SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

*THE ACHIEVEMENTS OF PHYSICAL CHEMISTRY.**

'PHYSICAL chemistry is the chemistry of the future.' These words, quoted from an address by Prof. Du Bois-Reymond, were used by Ostwald ten years ago in the introduction to the first number of the *Zeitschrift für physikalische Chemie.* In using these words Du Bois-Reymond looked forward to a time when it shall be possible to give a mathematical expression to all forms of chemical knowledge. The picture in his mind seems to have been that of a sort of astronomy of the atoms, in which the motions and forces within the molecules shall be known very much as are the motions and forces within the planetary system.

So far as any practical realization is concerned, the thought is still only a poetic fancy, and whatever progress, if any, may have been made, comes to us from organic rather than from physical chemistry. Indeed, it seems to have become the fashion on the part of several leaders in physical chemistry to speak slightingly of the atomic and molecular theories. Their thought appears to be that it would be better to confine ourselves to the purely empirical and mathematical concept of the atom and molecule and leave the idea of particles

* Address by the Vice-President before Section C—Chemistry.

which have an actual independent existence entirely in abeyance. It would, doubtless, be possible to give such definitions of atom and molecule as shall include only the results of our actual empirical knowledge and mathematical deductions therefrom. Such definitions would stand on a basis which is incontrovertible, and it is inconceivable that even the overthrow of the atomic theory, or any knowledge which may be gained in the future as to the nature of matter, could change them.

That such definitions possess great value is certain; and that it is very important to distinguish sharply between our positive knowledge and speculations and theories based on that knowledge, every one will admit; but, after all, unless we join that school of philosophy which teaches that there is no real existence outside of our own minds, there is some reality at the basis of and behind all the phenomena which we investigate. And it is the province of science to find out the truth about every real existence of which we can secure any tangible evidence. Our knowledge of atoms and molecules as actually existing particles is, doubtless, a purely speculative deduction from a multitude of diverse phenomena, and yet the mental picture connected with the concept has been, and still continues to be, of very great value in the development of our science. These mental pictures are vague and in many respects incomplete, it is true, and they doubtless do not correspond closely to the real existences for which they are, at present, our best expression; but, to one familiar with the very practical results which have been obtained in the domain of structural chemistry, it is difficult to conceive how such results would have been possible without their use.

While physical chemistry has made little or no apparent progress toward the goal marked out by Du Bois-Reymond, its practical achievements during the last ten or fifteen years have been very considerable, and it is to these practical achievements that I wish to turn our attention.

Whenever the subject of physical chemistry is mentioned our thoughts naturally turn to the subject of solutions. Not that physical chemistry has to do only or chiefly with solutions, for, as I understand it, physical chemistry has to do with all of those physical properties of matter which can only be understood by taking into consideration at the same time its composition; but rather because some of the most valuable results of physico-chemical researches have been made in this field, and because diversity of views has made this the chief recent battle-ground in chemistry.

Up to about eleven years ago our knowledge of solutions was almost entirely of an empirical character. No great generalization, similar to those which had long been known for gases, had been discovered. In 1885 J. H. van't Hoff[1] proposed his theory of osmotic pressure. The empirical basis for this theory lay in the experiments of many different workers, some of them made many years before. Studies in osmose date from the early years of this century and, indeed, some experiments were made more than a century ago. It was not, however, till 1867 that the discovery of true semi-permeable membranes was made. In that year M. Traube[2] showed that membranes may be prepared which will readily allow the passage of water, but which are totally impervious to certain substances in solution. Ten years later W. Pfeffer[3] conceived the idea of preparing such membranes in the interior of a solid partition. By exposing a cup of porous porcelain to the action of a solution of copper sulphate on one side and of potassium ferrocyanide on the other, a precipitate is formed within the mass of the porcelain which is permeable to water, but

which is impervious to the passage of sugar and of many other substances. With such cells the osmotic pressure was measured and was found to be surprisingly great. For a one and a-half per cent. solution of saltpetre it is more than three atmospheres. For sea water it would be about twenty atmospheres. Pfeffer's experiments were made with reference to their bearing on the action of organic cells and on other physiological questions, and it was eight years later before their extraordinary theoretical importance was pointed out by van't Hoff.

A careful study of the experimental data given by Pfeffer and others leads to the following conclusions:

First, the osmotic pressure is directly proportional to the concentration of the solution.

Second, the osmotic pressure is directly proportional to the absolute temperature. In establishing this law the experiments of Soret[4] are of especial interest. He subjected a solution of copper sulphate, contained in a vertical tube, to a temperature of 80° near the top and of 20° at the bottom. Under these circumstances the concentration increases below and diminishes above. After equilibrium was established it was found that the per cent. of copper sulphate in the two parts of the solution was inversely as the absolute temperature. The analogy with what would take place in a gas under the same conditions is clear.

Third, solutions which are isotonic at a given temperature contain in unit volume the same number of molecules of the dissolved substance. Another statement of the same law, which gives it also a quantitative expression, is that the osmotic pressure of a solution is the same as though the dissolved substance existed as a gas within the same space. The osmotic pressure of a one per cent. solution of sugar may be calculated by the same formula* which we should use to calculate the pressure exerted by one gram of a gaseous body having a molecular weight of 342 and contained in a volume of 100.6 cubic centimeters.

Every one recognizes, of course, that the laws which have been given for osmotic pressure are identical with the laws of Boyle, of Charles and of Avogadro for gases. Van't Hoff pointed out this analogy very clearly, but he did not give any clear explanation of what he considered as the real cause of the phenomena of osmose. He spoke, from the purely empirical side, of of the attraction which the solution exerts for pure water.[5] Ostwald in his Lehrbuch[6] is even more careful. He speaks of the cell as conducting itself as though there is within it a partial vacuum for water. These expressions are very similar to those of the older text-books, which speak of the expansion of gases as due to the repulsion of their particles for each other, and appear to me equally misleading and unsatisfactory. In a later paper,[7] in reply to a criticism by Lothar Meyer,[8] van't Hoff gives a clearer explanation in terms of the kinetic theory.

If we have a gas in a confined space and introduce into it a small amount of some volatile liquid the vapor of the liquid will rise and fill the space very nearly as though the gas were not present, and when equilibrium is reached the pressure will equal the original pressure of the gas plus the vapor pressure of the liquid. The explanation is that the pressure exerted on the surface of the liquid by the gas is not that of continuous matter, but is due to the

* $P = \frac{760 \times T.}{342 \times 0.045 \times 0.1006 \times 273}$

In this formula,

T = Absolute temperature.

342 = Molecular weight of cane sugar.

0.045 = One-half the weight of a liter of hydrogen.

0.1006 = Volume in liters of 100 grams of the solution.

bombardment of its surface by particles of discontinuous matter. The particles of the liquid find ample opportunity, therefore, to rise between the particles of the gas.

Let us take a second case, which has, however, as far as I am aware, never been realized. Suppose a vessel having a wall impervious to the molecules of one gas but previous to those of a second. If such a vessel containing the first gas is placed in an atmosphere of the second the molecules of the latter will pass the walls and enter the space occupied by the first, exactly as the molecules of the volatile liquid rise among the molecules of the gas above, and equilibrium will be established only when the pressure exerted by the second gas is equal within and without. The pressure within the vessel will then exceed that on the outside by exactly the pressure exerted by the gas whose molecules cannot pass the wall.

The case with osmotic pressure is very similar to that last mentioned. Here we have a semi-permeable wall actually realized. For instance, we may have a wall which will allow water to pass freely but which is impervious to the molecules of sugar. If pure water be on one side of such a wall, and a solution of sugar on the other, equilibrium can exist only when the pressure due to the water alone is equal on both sides; for the molecules of sugar, because of their discontinuous character, can exert no influence to cause the molecules of water to pass one way or the other, exactly as a gas can exert no permanent effect to prevent the vapor of a liquid from passing upward into it. In the end, therefore, the pressure on the side of the solution must exceed that on the side of the pure solvent by the amount of pressure due to the kinetic energy of the molecules of the dissolved substance. If we further suppose that this energy is the same in the liquid as in the gaseous state, and the laws of osmotic pressure give us every reason to believe that it is, the explanation is complete.

This explanation gives us a conception of liquids as very closely related to gases in many of their properties, the main difference being that in the liquid the molecule does not possess enough kinetic energy to separate it from the mass of neighboring molecules, although its motion within the confined space is very similar to that of the molecule of a gas.

But it is not only, nor indeed mainly, in his study of the phenomena of osmose that van't Hoff has rendered the greatest service. Very few perfect semi-permeable walls are known, and osmotic pressures are very difficult to measure directly, so that, if we were dependent on direct measurements, the theory would be of scarcely more than theoretical interest. Van't Hoff pointed out, however, that the concentration of a solution by the removal of the solvent, whether effected by a piston composed of a semi-permeable wall, by the evaporation of the solvent, or by the separation of crystals of the pure solvent by freezing, is in each case a reversible process analogous to the compression of a gas, and that, as with all other reversible processes, it is subject to the second law of thermo-dynamics. This made it possible to connect the lowering of the vapor pressure and the depression of the freezing point of solutions directly with their osmotic pressure. This has given an indirect determination of the osmotic pressure in thousands of different cases. As a practical result we have now at our disposal a large number of methods for the determination of the molecular weights of solid and liquid bodies.

The work of Raoult[9] in this field deserves especial mention, because he developed several methods of determining molecular weights from an empirical standpoint, before the theoretical development of the subject had been given by van't Hoff. Ra-

oult's[7] work attracted the attention of Victor Meyer, who made use of his methods in the study of certain stereomeric bodies upon which he was at work. And it is in connection with stereoisomerism that the new methods of determining molecular weights have, perhaps, been of the greatest practical value in the development of chemical science; for, without the positive proof that the bodies studied are metameric and not polymeric, the foundation for the belief that they are stereomeric would be comparatively weak.

It is probably through articles published by Victor Meyer[10] and Auwers[11] that cryoscopic methods for the determination of molecular weights were first brought to the attention of a wide circle of chemists. Since then a large number of workers have busied themselves with the subject, partly in the development of suitable forms of apparatus and methods of manipulation, partly in the study of the scope and degree of accuracy of the laws and of exceptions to them. The most important of the methods developed are those dependent on the lowering of the freezing point of solutions,[12] on the raising of the boiling point.[13] on the lowering of the vapor pressure,[14] on the determination of isotonic solutions by vegetable membranes[15] and by blood corpuscles, and on the lessening of the solubility of ether in water or of phenol in water by the addition of substances soluble in ether or phenol but not in water. In the last case the determination is either direct in the case of phenol, or by the rise of the freezing point of the water[16] owing to the withdrawal of ether from it.

As was to be expected, the laws of osmotic pressure are subject to numerous exceptions, or rather modifications, for, strictly speaking, no true law of nature is ever subject to an exception. That which, by a figure of speech, we call an exception is really a modification due to the simultaneous application of some other law. The modifications in this case are very similar to the modifications of Avogadro's law, which retarded its acceptance for nearly a half century. Vapor densities are abnormally high on account of the associative tendency of molecules, as in the case of acetic acid, or when too near the boiling point of the liquid, or low on account of dissociation, as in the case of ammonium chloride or of phosphorus pentachloride. In a similar manner the molecular weights of most acids when determined in solution in benzene are twice their normal value, while the molecular weights of electrolytes dissolved in water, and sometimes when dissolved in other solvents, are less than we should expect. In addition to the modifications of the law due to association and dissociation are other modifications similar to the modification of the laws of Boyle and Charles for gases which are highly compressed. These cases have been studied and formulæ for the deviation, based on the formulæ of van der Waals for compressed gases, have been given by Ostwald, Bredig and A. A. Noyes.[17] These formulæ give a satisfactory expression for the deviation in many cases of concentrated solutions. When we consider that strong solutions often give osmotic pressures of many atmospheres, and that the molecules of the bodies in solution are often much more complex than the molecules of most gases, it is readily seen that deviations of considerable amount may be expected.

In 1884 Arrheneus[18] published the results of researches on the electrical conductivity of solutions, on which he had been engaged for two years. In the course of his studies he was led to the conclusion that only a part of the molecules of an electrolyte are concerned in conveying the electrical current, and that it is necessary to distinguish between 'active' and 'inactive' molecules in this regard. The conductivity is greater,

in proportion to the amount of the electrolyte present, for dilute than for concentrated solutions, and for an infinite dilution the molecules would, presumably, become all 'active.' Arrheneus pointed out, also, that there is a close connection between the number of 'active' molecules as determined by the electrical conductivity of solutions and the 'avidity' of acids as determined by the thermo-chemical researches of Thomsen. His first explanation of the cause of the difference between the 'active' and 'inactive' molecules, was, however, unsatisfactory and was not well received.

Shortly after, in his first development of his theory of solutions, van't Hoff was compelled to admit that many substances in aqueous solutions cause a depression of the freezing point much greater than they should in proportion to their molecular weights. He expressed the deviation by use of a factor, 'i,' which is, for electrolytes, always greater than unity and expresses the number of times the depression exceeds the theoretical depression as calculated from the molecular weight. This factor was at first considered to be a constant, but it is now known that it is variable and that it increases with the dilution. The obvious meaning of this factor is that the molecules of electrolytes are separated into two or more parts when dissolved in water, or other liquids which have a similar effect in causing electrical conductivity. But, just as chemists were very slow to see that the abnormal densities of ammonium chloride and of many other substances are due to dissociation, so van't Hoff did not draw a conclusion which seemed to be so contradictory to all preconceived notions about the bodies in question. Arrhenius, however, saw the logical conclusion, and his studies had prepared him for its acceptance. As a result, he proposed, in 1887, his theory of electrolytic dissociation.[19]

This theory, which seemed at first very improbable, has shown itself capable of coordinating the facts of many diverse fields of work and has proved more valuable in the incentive which it has given to research and more prolific of results than any other theory proposed during the last decade. According to the theory, an electrolyte when dissolved in water, and sometimes when dissolved in other solvents, is separated more or less completely into its ions.

The empirical basis for the theory lies in the correspondence between electrolytic conductivity and the divergence from the normal depression of the freezing point and lowering of the vapor pressure; in the correspondence of both with the 'avidity' of acids which has already been referred to; in the quantitative connection between each of these and the chemical effect of acids as shown in the inversion of cane sugar and saponification of methyl acetate; in the satisfactory explanation which it gives for the independent migration of ions during electrolyses as established by the work of Hittorf, Kohlrauch and others; in the fact that an electrolyte obeys the same law for dissociation with increasing dilution as a gas under diminishing pressure, first pointed out theoretically by Ostwald and Planck,[20] and then experimentally established by Ostwald, Wildermann,[21] Loomis,[22] and others; and in general by the fact that the properties of a dilute solution of an electrolyte are dependent on the sum of the properties of the ions present rather than on the properties of the chemical compound which those ions may combine to produce. It would take me too far to illustrate this last statement as shown to be true of the density, color and other properties of solution.

The theory has thrown light upon many chemical riddles and has placed the chemist in a position to predict phenomena which could formerly be known only as the result of experiment. It suggests at once

the distinction between reactions of ions and reactions of bodies which do not undergo ionic dissociation. The former take place in solutions at ordinary temperatures and so instantaneously that the time factor cannot be measured; the latter frequently require an elevated temperature and are sometimes very slow. The distinction is, perhaps, a practical, rather than a strictly logical one, for theoretical considerations lead us inevitably to the conclusion that only additive reactions, and in many cases not even those, can take place without a previous dissociation of some sort. In this view the distinction between ionic reactions and others is that in solutions of electrolytes a considerable portion of the compounds have undergone dissociation; and as any ion is removed by precipitation, or otherwise, the remainder of the compound of which it is a part undergoes rapid dissociation, owing to the resulting dilution of the solution. In such cases the dissociation appears to take place almost exclusively at one point in the compound, and the reactions are clean and practically quantitative. In what may be called non-ionic reactions, on the other hand, the initial dissociation appears to be trifling and, notably with organic compounds, may take place at several points; the reactions between the resulting parts must be slow and may give rise to a variety of compounds.

In accordance with the theory, only those elements or groups which exist as independent ions in a solution enter readily into combination with other ions. Hence an atom which forms a part of a complex ion as the iron of ferro- or ferri-cyanides and the chlorine of chloro-platinic acid and of potassium chlorate cannot be detected by the ordinary reagents for these elements. This principle is of fundamental importance for analytical chemistry and has, of course, in its empirical form, been long recognized.

In the case of analytical chemistry, especially the new theories of physical chemistry seem destined to transform what has been, hitherto, an almost exclusively empirical science and raise it to a higher plane. Two illustrations of practical applications of the theory in this field may be of interest.

The first is with regard to the indicators used in acidimetry. It has long been known that the same indicator is not equally satisfactory in all cases, but the reason has never been clearly stated till recently. The principles on which the discussion depends are these: an acid solution is characterized by the presence of free hydrogen ions, a basic solution by the presence of free hydroxyl and free metallic ions; in the case of a strong acid or base the number of hydrogen or hydroxyl ions is large in proportion to the quantity of the acid or base present, while in the case of a weak acid or base the number of ions is small; in other words the difference between strong and weak acids and bases is that the dissociation factor of the former is very much the larger. The indicators in use are relatively weak acids or bases for which the free ions possess a different color from that of the pure acid or base. Thus phenol phthaleïn is colorless, while its ion is red; litmus is red, while its ion is blue. In the presence of hydrogen ions the dissociation of each of these substances is diminished in accordance with the well known law of dissociation that the presence of one of the products of dissociation decreases the dissociation of the compound. Hence in acid solutions these bodies are so little dissociated that the color of the compound, and not that of the ion, appears. In alkaline solutions, however, the color of the ions is developed, since the potassium and sodium salts, even of very weak acids, are largely dissociated in dilute solutions.

There is, however, a very considerable difference in the dissociation factors for

the different indicators. The dissociation factor is much higher for methyl orange and for cochineal than for litmus and phenol phthaleïn, and while the dissociation factor of hydrochloric and similar acids is so high that a very small excess will cause the change in color, even of methyl orange, the dissociation factor for many acids, and especially for most organic acids, is so low that a quite appreciable excess is required, and the change in color will be slow and uncertain. Hence methyl orange and cochineal are entirely unsuited for the titration of weak acids, and litmus or phenol phthaleïn must be used. For weak bases, and notably for ammonia, the conditions are reversed. The salts of such bases with phenol phthaleïn, or with litmus, undergo hydrolysis in dilute solutions, and a considerable excess of the base will be required before the ions characteristic of the indicator will appear. The salts of the same bases with methyl orange or cochineal are not so readily hydrolyzed, and these indicators are more suitable.

A practical complication arises from the presence of carbonic acid in most of the solutions which we titrate. I will not take the time here to discuss the details of the theory which points out very clearly that, for accurate results, carbonic acid must be excluded from solutions in which litmus or phenol phthaleïn are employed, while, if concentrated, methyl orange or cochineal may be used satisfactorily for strong acids.

The other illustration of the application of the principles of physical chemistry to an analytical problem is one recently given by Stefan Bugarsky.[23] A great many methods for the separation of bromine and chlorine have been developed, but nearly or quite all of them rest on a purely empirical basis. Bugarsky has studied the subject from an entirely different point of view. Sometime since Bancroft[24] determined the electromotive forces developed between oxidizing and oxidizable solutions connected by an indifferent electrolyte, and with a platinum electrode immersed in each. The results may be considered as giving a quantitative expression for the relative oxidizing and reducing power of the various substances studied. Among other things it was found that, no matter what substance was oxidized, iodic acid with sulphuric acid develops a greater electromotive force than bromine with potassium bromide and less than chlorine with potassium chloride. It appears, therefore, that iodic and sulphuric acids together should liberate bromine, but not chlorine, from a solution containing bromides and chlorides. The practical application of this theoretical conclusion appears to have been entirely successful.

It is not alone in chemistry that the theories of osmotic pressure and of electrolytic dissociation have proved of practical value. Nernst has developed from these theories a theory for the cause of the electromotive force in batteries, which, while it may not, as yet, have received general acceptance, is a more useful expression for our present knowledge than any previously proposed. The most important conception at the basis of this theory is that of what may be called a solution pressure for metals, corresponding in some sense to the vapor pressure of liquids. When zinc, for instance, is in contact with water, or an aqueous solution, this solution pressure is a force impelling the atoms of zinc to pass into solution. In order that they may do so, however, each atom must pass over into the state of an ion; that is, it must receive a charge of positive electricity which is carried with it into the solution. But only a very few atoms can pass into solution before the negative charge left in the mass of the zinc in proportion as the positive ions separate from it will cause such an accumulation of zinc ions in proximity with the zinc as to balance the solution pressure. If, however,

an opportunity is given for the escape of the negative charge from the zinc, and at the same time positive ions are allowed to escape from the solution at some other point, the zinc will continue to dissolve and currents of electricity will be set up. Thus, in the Daniell, or gravity cell, zinc ions pass into solution and a corresponding number of copper ions are deposited. The force which causes the movement of the ions, and with them the transference of electrical energy within the cell, is mainly the very high solution pressure of the zinc as compared with that of copper. Other factors, such as the osmotic pressure of zinc ions already in solution, which tends to conteract the solution pressure of the zinc, the osmotic pressure of copper ions which aids in the separation of the copper, and the different velocity of translation for various ions which may cause differences of potential when the fluids of the cell are not homogeneous, are most of them comparatively small in their effect.

No means has been found for the direct determination of the solution pressure of metals, but it may be calculated from the difference in potential between a metal and a solution of one of its salts. Methods for the determination of the latter have been devised by Ostwald,[25] and improved by Paschen.[26] By the use of these and other constants which the researches of physical chemistry have placed in his hands, the physicist can now calculate the electromotive force which can be obtained by various combinations of metals and solutions. On this side the theory has rendered essentially the same service for the galvanic cell which the atomic theory rendered for chemical compounds when it furnished the means for calculating their percentage composition. As in the early days of the atomic theory, many of the constants in question are imperfectly known, but since the theory has shown clearly their interdependence, new means for their determination and for the control of their accuracy are constantly being discovered.

Every one who is familiar with the extremely wasteful character of all processes now at our disposal for the transformation of chemical into mechanical energy must have had the thought that there is surely some means of saving a part of the enormous loss. At present the attention of the scientific world is turned toward the transformation of the chemical energy of coal into electrical energy as the probable solution of this problem. It seems to be almost certain that physical chemistry has already made clear the principles by means of which such a transformation may be accomplished. Indeed, Dr. W. Borchers,[27] by the use of a solution of cuprous chloride with producer gas, or carbon monoxide on one side and air on the other, has already obtained an electrical current which corresponds to a transformation of thirty per cent. of the chemical energy into electrical. This is an efficiency three times that of the best steam engines. There is no probability that this method can ever be practically useful, but that a practical method will soon be discovered is, at least, possible.

I have thus far spoken of the achievements of physical chemistry mainly in the direction of the development of the theories of osmotic pressure and of electrolytic dissociation. It is in this field that the most valuable practical results have been secured, because it is here that a new, far-reaching, and extremely useful theory has been developed. But work in physical chemistry has been extremely active in many other directions as well.

The most brilliant chemical discovery of the last decade was a result of the careful study of a single physical property of nitrogen. And, owing to the peculiar character of argon and helium, their further study

has been almost exclusively on the physical side.

Ramsey and Shields,[28] by their work on the surface energy of homogeneous liquids, have developed a method for the determination of the molecular weights of this class of bodies.

Traube's exhaustive study of the specific gravity of solutions, promises, if all that he claims be true, and much of it seems to be, to bring order out of an almost interminable chaos of empirical data. Among other things his work has given a new and very rapid method for the determination of molecular weights.

I will not take the time to refer in detail to the work of Brühl and others on the refraction and dispersion of light as dependent on the composition and structure of bodies; to the work of Thomsen, of Stohman and of Berthelot upon thermo-chemistry; to the work of Guye, Walden and others on specific and molecular rotation, and of Perkin on electro-magnetic rotation of polarized light; and to the work of Rowland on spectrum analysis.

In all of these fields and in many others a vast accumulation of empirical data has been secured. This wealth of experimental material has been accompanied and supplemented by theoretical discussions, and many interesting relations have been discovered. Physical chemistry has proved one of the most enticing and profitable fields for work in recent years and claims many enthusiastic investigators in our own country as well as abroad. In the development of the subject perhaps no one has contributed more than Ostwald by his Lehrbuch and by his ably edited Zeitschrift für physikalische Chemie. We may congratulate ourselves that our workers in America are now to have a journal of their own, and we may confidently hope that the new *Journal of Physical Chemistry* will contribute much toward 'the chemistry of the future.'

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SECTION C.—CHEMISTRY.

SECTION C. of the American Association for the Advancement of Science was called together for organization on Monday, August

31st, at 11:30 a. m. Vice-President W. A. Noyes of Terre Haute, Ind., was in the chair, and F. P. Venable, of Chapel Hill, N. C., was Secretary.

Dr. E. A. de Schweinitz, of Washington, was chosen member of the Council, and Dr. Charles H. Herty, of Athens, Ga., Press Secretary. Dr. A. L. Springer was elected member of the Nominating Committee. Drs. McMurtrie, Norton and Baskerville were added to the committee to nominate officers of the Section, and Prof. F. C. Phillips, Prof. S. A. Lattimore and Prof. F. W. Clarke were added to the Sectional Committee.

The Section then adjourned until 4:30 p. m. At that hour the Section assembled to hear the Vice-Presidential address of Prof. W. A. Noyes. He was introduced in a few appropriate words by the Vice-President for 1895, Dr. Wm. McMurtrie, and made an address on 'The Achievements of Physical Chemistry,' which is printed in full above.

On Tuesday the Section assembled at 11 a. m. and the regular program of papers was taken up.

Prof. F. W. Clarke reported for the committee on indexing chemical literature. In addition he reported work now in progress by Dr. Bolton on the preparation of an index of inaugural dissertations. This is the first effort to index this matter.

Dr. Edward Hart reported on the loan made by the Association to him for prosecuting work on the method of preparation and purification of glucinum. The work is not yet complete, but he hopes to prepare glucinum on a commercial scale by reduction of the oxide with magnesium in a glucina crucible. The Section expressed approval of the work.

The following papers were presented before the Section.

PHYSICAL CHEMISTRY.

A. A. Noyes and G. C. Abbott, Massachusetts Institute of Technology: on 'Determination of Osmotic Pressure from Vapor Pressure Measurements.' The authors derive, from thermo-dynamical considerations, a formula by means of which the osmotic pressure can be calculated directly from the vapor pressure, and deduce from it the law that osmotic pressure and work are directly proportional to one another, no specific volume correction being required as assumed by many previous investigators. The authors further describe an experimental method for determining vapor pressure and communicate measurements on ether solutions of napthaline and azo-benzene. The results show that vant' Hoff's law of the identity of osmotic and gas pressure under similar conditions is fully confirmed, and that the osmotic pressure varies almost directly as the concentrations.

W. D. Bancroft, Cornell University: 'Distillation with Vapor.' From experimental data the author is led to conclude that solids present in vapors obey certain chemical laws, and are not simply mechanically suspended in the vapor. The author is now engaged in a revision of the experimental data.

H. C. Jones, Johns Hopkins University: 'A Physico-chemical Study of Water Solutions of some of the Alums.' By electrical conductivity measurements the author shows that in rather concentrated solutions there is present some of the undissociated double salt. In very dilute solutions, complete dissociation takes place.

J. H. Kastle, State College of Kentucky: 'The Hydrolysis of the Sulphonic Ethers.' The hydrolysis of the sulphonic ethers is brought about by water and also by the alcohols. It was found that in solution in acetone, water is about 3.5 times stronger in its hydrolyzing power than methyl and ethyl alcohol, which were found to be about equal in this capacity. It was found also that acids do not act by catalysis on the sulphonic ethers, but actually enter into double

decomposition with them. It was found further that not only acids, but all electrolytes, react in the same way on the sulphonic ethers, and as might be expected all electrolytes were found to react upon the sulphonic ethers much more rapidly than water.

C. E. Linebarger, Chicago: 'On the Nature of Isomorphous Mixtures.' The author gives an historical review of the two views held as to the nature of isomorphous mixtures, namely, that of mechanical mixtures, or solid solutions. From experiments upon the rate of desiccation of isomorphous mixtures of sulphates the author concludes that this is a case of solid solution and not a mechanical mixture.

R. B. Warder, Washington, D. C.: 'A Discussion of Lichty's Experiments on the Speed of Esterification.' The 'coefficient of speed' in each case, as deduced by means of the formulas for reversible reactions, is shown to vary in the progress of the reaction; first diminishing, then nearly constant or slightly increasing, and finally diminishing very rapidly. Suggestions are thus gained regarding the nature of secondary influences involved.

H. M. Goodwin, Massachusetts Institute of Technology: 'The Hydrolysis of Ferric Chloride.' The author calculates the degree of hydrolysis of ferric chloride from conductivity and freezing point determinations, finding it to be inappreciable in fairly concentrated solutions (*e. g.*, decinormal), but nearly complete in more dilute ones (*e. g.*, millinormal). He also describes and discusses the remarkable increase in conductivity with the time which such solutions manifest.

A. A. Noyes and H. M. Goodwin: 'The Viscosity of Mercury Vapor.' By determinations of the viscosity coefficients of gases it is possible to calculate the relative cross-sections of the molecules of the gases. From measurements of the viscosity of mercury and carbon dioxide it is found that the spaces between the atoms of molecules are probably not large. The authors conclude that atoms and molecules are of the same order of magnitude.

INORGANIC CHEMISTRY.

F. W. Clarke, Washington, D. C.: 'Some Points in Nomenclature with regard to Analysis of Mineral Water.' It was pointed out that in the light of modern theories of solution the present method of reporting water analyses are totally erroneous. Suggestions were asked as to nomenclature in case of reporting SO_4, CO_3, etc.

C. H. Herty and H. V. Black, University of Georgia: 'The Alkali Tri-Halides.' The authors show that the successive crops of crystals obtained in the preparation of rubidium dibromiodide are identical, confirming thus the previously held view that these substances are true chemical compounds.

E. Goldsmith, Philadelphia: 'The metamorphosis of Fossil Bone into a mineral.' The author showed the substitution of carbonic acid for phosphoric acid, calcium carbonate crystallizing as aragonite.

J. L. Howe, Washington and Lee University: 'A Bibliography of the Metals of the Platinum Group.' This work will be ready for print soon.

J. L. Howe: 'Examination of Water and Deposits from a Lake in Yucatan.' The deposits (mud) proved to be almost pure gypsum. A sample from the middle of the lake contains a large quantity of hydrogen sulphide, while another sample taken from the border contained none.

T. W. Richards and H. G. Parker, Harvard University: 'A Revision of the Atomic Weight of Magnesium.' From determinations of chlorine in magnesium chloride the authors find the atomic weight of magnesium to be 24.36.

ORGANIC CHEMISTRY.

William McPherson, Ohio State University: 'Hydrazones of Quinones.' This is an extension to the naphthoquinone of the previously published work on the action of phenyl hydrazine on quinones. Zincke's idea is confirmed, that in the action of phenyl hydrazine on a naphtha quinone there is a migration of a hydrogen atom of phenyl hydrazine to the C=O group.

A. A. Noyes: 'Synthesis of Diethyl Hexamethylene Ether and other Ethers from Trimethylene Glycol.' By replacing the hydrogen of one of the hydroxl groups by sodium, then replacing this sodium by the ethyl group, then replacing the remaining hydroxyl group by chlorine, a substance is obtained from which may be prepared the diethyl hexamethylene ether.

A. A. Noyes: 'Formation of Diacetylenyl (Butaiidine) from Copper Acetylene.' The following transformations were effected: $Cu-C=C-Cu+2CuCl_2=Cu-C\equiv C-C\equiv C-Cu$. This was transformed into $H-C\equiv C-C\equiv C-H$ (Butaiidine).

This hydrocarbon takes up directly six atoms of bromine.

W. A. Noyes, Rose Polytechnic Institute: 'Camphoric Acid.' The author shows that one of the carboxyl groups of camphoric acid is primary, the other is tertiary. He further shows that camphoric acid is a derivative of succinic and not of glutaric acid. From a study of the constitution of campholitic acid he hopes to obtain accurate evidence upon the constitution of camphoric acid.

P. Fireman, Washington, D. C.: 'Introduction of Alkyl Iodides into Phosphines by means of Ethers.' This was accomplished by heating phosphonium iodide with ethers in sealed tubes. Reaction takes place more readily than with alcohol.

S. H. Bear and A. B. Prescott, University of Michigan: 'Dipyridine Methylene Iodide and the Non-formation of Corresponding Donopyridine Products.' This is a continuation of work previously published on the periodides of the nitrogen basis.

C. Loring Jackson and W. R. Lamar, Harvard University: 'On the Behavior of Trichlordinotrobenzol with Various Reagents,' 'On the action of Nitric Acid on Potassic Cobalticyanide,' 'On the action of Sodic Ethylate on Dinitranissic Acid.' In the absence of the authors, Dr. Howe persented a brief abstract of these three papers.

DIDACTIC CHEMISTRY.

F. P. Venable, University of North Carolina: 'The use of the Periodic Law in Teaching General Chemistry.' The author advocated adherence, as far as possible, to the periodic law in teaching general chemistry.

W. P. Mason, Rensselaer Polytechnic Institute: 'Chemistry at the Rensselaer Polytechnic Institute.'

A. A. Noyes: 'Laboratory Instruction in Organic Chemistry.' The author called attention to the need of greater ability on the part of students to identify the more common organic compounds, or, at least, the classes of compounds. He furnishes students with group reactions of common organic compounds, then with methods of separation.

A. A. Noyes: 'The Teaching of Physical Chemistry.' The author asked that courses in theoretical chemistry include more of the recently developed views and that such a course be accompanied by a laboratory course.

Ellen H. Richards, Massachusetts Institute of Technology: 'Instruction in Sanitary Chemistry at the Massachusetts Institute of Technology.'

T. H. Norton, University of Cincinnati: 'Points in Teaching Technical Chemistry.' The author pointed out the necessity of visiting several commercial plants with the

class. He then called attention to the preliminary preparation which should be had and showed how the details of the plant could be better understood by the aid of a printed syllabus, the various parts of the apparatus being labelled in accord with the syllabus. Application of points of interest should be made in laboratory work. Well written accounts of the visit should be made, and finally, analyses should be made of samples obtained on the trip, especially as showing the quantitative proportion of material used and produced. In the discussion which followed all were unanimous that there was great necessity for higher chemical training and training in mechanical engineering for technical chemists.

G. C. Caldwell, Cornell University: 'The Aim of Qualitative Analysis.' It is much more than mere identification of particular substances; it furnishes fine training in careful manipulation and accurate observation; the student learns the importance of small things, his judgment is trained. It requires a thorough study of wider fields of chemistry and teaches classification.

A. L. Green, Purdue University: 'The Teaching of Qualitative Analysis.' This was an account of the specific method of teaching quantitative analysis at Purdue.

Ellen H. Richards: 'Some points in the use of Depth of Color as a measure of Chemical Contents.' This is a continuation of the line of work reported on at the Springfield meeting.

ANALYTICAL CHEMISTRY.

J. L. Howe and P. S. Mertins, Washington and Lee University: 'Notes on Reinsch's test for Arsenic and Antimony.' The work shows that an experienced observer will never fail to distinguish arsenic and antimony by this test.

Erwin E. Ewell, Washington, D. C.: 'A new form of Laboratory Condenser.'

Erwin E. Ewell: 'A Method of Manipulation for the Colorimetric Determination of Ammoniacal Nitrous and Nitric Nitrogen in Bacterial Culture.'

H. W. Wiley, Washington, D. C.: 'A Modified form of the Ebullioscope.'

TECHNICAL CHEMISTRY.

A. R. Leeds, Stevens Institute: 'Recent developments in the Purification and Filtration of Water.' This paper was largely historical. The author takes the position that it is better to purify water at hand than go long distances for it.

F. C. Phillips, Allegheny, Pa.: 'Some Properties and uses of Natural Gas.' From comparison of the composition of natural gas with that of coal gas, the author concludes that their methods of formation are not the same.

F. C. Phillips: 'A new Method for the Determination of Sulphur in White Iron.'

C. L. Reese, Charleston, S. C.: 'On Recent Improvements in the Manufacture of Sulphuric Acid.'

H. A. Weber, Ohio State University: 'Use of Coal for Colors in Food.' From experiments on four coal-tar colors—methyl, orange, coraline yellow, saffroline and magenta—the author finds that no one of these affects both peptic and pancreatic digestion, but that each affects seriously one form or the other. In the discussion which followed it was held that too much importance is attached to such experiments, owing to the extremely small quantities used in food stuffs.

Erwin E. Ewell: 'The Alkaloids of Anhelonium Lewinii (Mescal Buttons).'

SANITARY CHEMISTRY.

W. P. Mason: 'Well Water.' The author considers that impurities from the surface may come through soaking, in addition to surface entrance. He considers well-selected water sources much better than domestic wells. It is noticeable that in rural districts farmers are especially

careless with the disposition of refuse matter.

E. A. de Schweinitz, Washington, D. C.: 'Value and Use of Formaldehyde as a Disinfectant.' Anthrax, Tetanus, etc., are destroyed by formaldehyde. It possesses many good points as a disinfectant. It is a good deodorizer, only a small quantity being required, 1 cc. in ten liters of water. This is applied by spraying. It is a good preventative of decomposition. The amount of the gas in a confined space is determined by absorption in strong caustic soda or alkaline permanganate. One objection to its use has been the length of time necessary to remove the sharp odor of the formaldehyde. This can be largely hastened by spraying with ammonia.

E. G. Smith, Beloit College, Wis.: 'Observations on the Sanitary Nature of the Mississippi River Water at Different Seasons.'

AGRICULTURAL CHEMISTRY.

L. L. Van Hyde, Geneva, N. Y.: 'The work of the Agricultural Chemists of America.' The author gave a general review of the various lines of investigation pursued by the agricultural chemists. He pointed out what valuable service had been rendered in preventing fraudulent practices. An account was also given of the Association of Official Agricultural Chemists.

S. M. Babcock and H. L. Russell, University of Wisconsin: 'Conditions affecting the Normal Viscosity of Milk,' 'On the Restoration of the Viscosity of Pasteurized Milk.'

BIOLOGICAL CHEMISTRY.

V. K. Chestnut, U. S. Department of Agriculture: 'Andromedotoxin, the Poisonous constituent of the Ericaceae and its Relation to some Food Products.' It has been shown that honey from bees feeding on the plant contains the poison; further that meat of animals feeding on the leaves contains the poison and is a source of contamination.

On Thursday the Council of the A. A. A. S. authorized the fusion of Section C with the summer meeting of the American Chemical Society, the first two days of the meeting to be conducted officially by those of the American Chemical Society. The members of the American Chemical Society are to have the privilege of reading papers in Section C, and *vice versa*.

This matter is subject to the action of the Council of the American Chemical Society.

Section C nominated Professor Wolcott Gibbs, of Newport, R. I., to be an honorary member of the A. A. A. S. The Secretary was ordered to cast the ballot.

Dr. William P. Mason was nominated for Vice-President of the Section and Prof. P. C. Freer, for Secretary for the year 1897.

F. P. VENABLE, *Secretary*,
and CHAS. H. HERTY,
Press Secretary Section C.

THE EMBLEMATIC USE OF THE TREE IN THE DAKOTAN GROUP.*

THE tribes of the Dakotan or Siouan linguistic stock aggregate in number about 45,000 Indians. Grouped according to a close relationship of language, we find in the United States: 32,000 in the Dakota; 4,000 in the Omaha, Ponka, Quapa, Kanza and Osage; 800 in the Iowa, Otoe and Missouri; 2,200 in the Winnebago, and 3,000 in the Hidatsa, Mandan and Crow tribes. The remaining 3,000 are widely scattered, with the greater part living in the provinces of Canada.

At the beginning of the seventeenth century a number of tribes belonging to this stock dwelt on a strip of the Atlantic coast, now within the limits of North and South

*Address by the Vice-President, before Section H—Anthropology.

Carolina, extending as far west as the Alleghanies and north to the Maryland line, and controlling the headwaters of the streams flowing westward. They were in constant warfare with their Algonquian and Iroquoian neighbors, and were exterminated as tribes within the historic period. The majority of the Siouan Indians were already beyond the Mississippi, where they were met by early explorers, and where they now dwell. We find the purport of their traditions to be that they were slowly driven from their eastern home by implacable enemies, and that once beyond the Mississippi, they spread to the northern tributaries of the Missouri, westward to the Rocky Mountains, and south to the Gulf of Mexico, where recent investigations have brought to light a remnant of the Biloxi.

Contact with Algonquian, Iroquoian, Muskhogean, Caddoan and Kioan stocks, during the period of progress over this vast tract of country, has left its traces in the Siouan rites and customs; but the uncertainty that still clouds the past history of this people makes it difficult to determine when certain rites were adopted, or to gauge with accuracy the modifying influences of other stocks upon native usages and beliefs. From the scant records left by early travellers, with the fragmentary nature of the information still obtainable from the few scattered survivors of the eastern and southern tribes, a full reconstruction of their social and religious customs is impossible; but enough can be discerned to indicate that the eastern, southern and western tribes were all under the influence of cults which seem to have been fundamentally the same.

In this paper is offered a slight contribution to the early history of social and religious development, inasmuch as in tracing the emblematic use of the tree in the Siouan linguistic group we follow a people from a comparatively primitive condition, living in isolated bands, independently of each other, to their organization within the tribal structure, compacted by the force of common religious beliefs.

That ideas are the ruling force and 'the constructive center' of human society is readily conceded as applicable to our own race. It is equally true of the Indian; but in according this power to ideas the modifying influence of environment is not to be overlooked. One cannot conceive of man apart from environment; his contact with it is the very condition of being. As Herbert Spencer has phrased it, life is 'the continuous adjustment of inner relations to outer relations.'

This 'adjustment' of man to his environment is the work solely of ideas, and the process, as evinced in this group of Indians, goes to show that those ideas which have formed 'the constructive center' of the tribe are religious ideas.

Indian religions seem to have been subject to the same laws that have governed the development and growth of religions on the eastern continent. There, we know the several systems to have been begun with the simple utterances of a seer, which, as they were passed from mouth to mouth, became more and more clouded with interpretations, gradually expanded in detail, and finally formulated into ceremonials with attendant explanatory and dramatic rites. As time rolled into centuries, these ceremonies, with their accessory priests, came to be regarded as of supernatural origin, endowed with superhuman power, and authorized to exercise control over the affairs of the tribe or nation; but the one living germ within the ponderous incrustation of doctrine and ceremony, that had accumulated throughout ages, was still the surviving, vitalizing thought of the seer.

Turning to America, to the group of Indians of our especial study, we find traces of a similar history; for, penetrating beneath the varied forms of their religious

rites, we come upon a few fundamental conceptions or thoughts, the most dominant of which, perhaps, is the idea of the all-permeating presence of what we call life, and that this life is the same in kind, animating all natural forms and objects alike with man himself. Coordinate with this idea, which has received the name of animism, is that of the continuity of life, that whatever has once been endowed with it must continue to be a recipient of it ; in other words, whatever has once lived must continue to live.

There is no reason to think that, at any time in the past, it was possible for the idea of animism, or for any other idea, to have fallen into the mind of every savage simultaneously, as a cloud-burst drenches the plain. Ideas have ever made their way as they do now, slowly, and by being communicated and talked over. The idea of animism is a very remarkable one. It has been so built into the mind of the race that it is difficult to imagine a time when it was not ; and yet there was such a time, a time when man stood dumbly wondering at the birds and beasts, assailed like himself by hunger and finding food from the same supply ; at the alternation of day and night ; and at the destructive and vivifying effects of the storm. But these wondering observations were like so many disconnected fragments until some thoughtful mind caught the clue that led to the bold and clarifying thought that all things were animated by a common life, and that man was not alone upon the earth with strange and alien creatures, but was surrounded by forms replete with life like his own, and therefore of his kindred.

This mysterious power or permeating life was called in the language of the Omaha and Ponka tribes, Wa-ka*n*-da. This word is now used to designate the Deity. The original meaning, while conveying the idea of the mysterious, something hidden or unseen, also implied the power to bring to pass. Wa-ka*n*-da-gi, an adverbial form of the word, is applied to the first putting forth of a new faculty, as when a child first walks or talks, but the word wa-ka*n*-da-gi would not be used to express the resumption of faculties lost by sickness or accident.

Fourteen years ago, while sitting with me in his tent, a thoughtful old Dakota Indian, who had never come under missionary influence, spoke of his native religion, in which he was a firm believer. He explained the teaching of his fathers, and tried to make me understand that the mysterious power which animates all things is always moving and filling the earth and sky. He said, " Every thing as it moves, now and then, here and there, makes stops. The bird, as it flies, stops at one place to rest in its flight, and at another to build its nest. A man when he goes forth stops when he wills ; so the mysterious power has stopped. The sun, the moon, the four directions, the trees, the animals, all mark where it has stopped. The Indian thinks of all these places, * * * and sends his prayers to reach the mysterious power where it has stopped."

This Indian had evidently been taught that the power pervading all things was one in kind, and possessed of a quality similar to the will power of man. He said, " A man when he goes forth, stops when he wills ; so the mysterious power has stopped."

The Indian conceives of Wa-ka*n*-da as dowed with like, though greater powers than those possessed by man. The prayer chanted by every Omaha when he goes out to fast, seeking a vision :

"Wa-ka*n*-da dhe-dhu wa-pa-dhi*n* a-ta*n*-he."

Wa-ka*n*-da here needy I stand, is an appeal to something that is believed to be capable of understanding the needs of a man, and implies a conception of Wa-ka*n*-da that is anthropomorphic. But the

Indian does not apparently think of Wa-kan-da as apart from or outside of nature, but rather as permeating it, and thus it is that to him all things become anthropomorphized.

In a Ponka ritual the following address is made to the tree, as represented in the framework of the lodge in which the ceremony takes place:

"Oh! Thou Pole of the Tent, Ethka;

"Along the banks of the streams, Ethka;

"With head drooping over, there Thou sittest, Ethka;

"Thy topmost branches, Ethka;

"Dipping again and again, in very truth, the water, Ethka;

"Thou Pole of the Tent, Ethka; (The Tree now speaks.)

"One of these little ones, Ethka; (That is, the suppliant.)

"I shall set upon one (of my branches), Ethka;

"The impurities, Ethka,

"All I shall wash away, Ethka."

The tree is supposed to take the man on its branches, as in one's arms, and dip him in the stream, where 'all within the body' is 'cleansed.'

Long life is desired, and the Rock is invoked;

"Oh! Aged One! Ethka;

"Thou sittest as though longing for something, Ethka;

"Thou sittest like one with wrinkled loins, Ethka;

"Thou sittest like one with furrowed brow, Ethka;

"Thou sittest like one with flabby arms, Ethka." (The Rock now speaks.)

"The little ones (the people) shall be as I am, whosoever shall pray to me properly" (*i. e.*, ceremonially).

Many other illustrations could be given to show the Siouan Indian's anthropomorphic conception of nature.

With the acceptance of the idea that all things were quickened with the same life, came the belief that a mysterious relationship existed between man and his surroundings, and it naturally followed that, in his struggle for food and safety, he should seek to supplement his own strength by appealing to his kindred throughout nature; should 'send his prayers to reach the mysterious power where it has stopped.' Said a venerable Indian to me one day, "the tree is like a human being, for it has life and grows, so we pray to it and put our offerings on it, that the mysterious power may help us."

Coordinated with these ideas concerning nature was that of the continuity of life, which could not but lead to a belief in dual worlds with interchanging relations; thus we find that these Indians were firmly convinced that the dead camp in the unseen world, as they did while upon earth, each gens having the same relative place in the tribal circle, and each person at death going to his own gens.

Among the Ponkas the Ta-ha-u-ton-a-zhi division of the Ni-ka-pa-shna gens, whose totem is the deer, put deer-skin moccasins upon their dead, that they may be recognized by their kindred, and not lose their way in the other world. Among the Otoes, when an Indian dies his face is painted in a manner peculiar to his gens, by one having the hereditary right to perform this act, who says to the dead: "In life you were with those you have now left behind. Go forward! Do not look back? You have met death. Those you have left will come to you."

The ancient chiefs, who 'first took upon themselves the authority to govern the people,' are still active, and through the rituals chanted at the installation of tribal officials, as through a medium, they continue to exercise their functions and to confer authority on their successors. The rituals call upon the animals which had

supernaturally appeared to the first rulers, 'The Crow, with frayed neck feathers; The Wolf, with tail blown to one side;' and they appeal to both chiefs and animals to remember their promise, and to continue to guide the people into safety and plenty through their successors now being ordained.

The Legend of the Sacred Pole of the Omahas, handed down from generations, gives a rapid history of the people from the time when 'they opened their eyes and beheld the day,' to the completed organization of the tribe and the institution of the rites of the Sacred Pole. From it we learn that changes in the daily and material progress of the people did not come about through miraculous intervention, but through the mind of their wise men; and that every step in the path of progress was the result of 'thought.' 'And the people thought,' is the constant prelude to every betterment or invention. By 'thought' they learned how to make fire, to build lodges, to weave, and finally to institute religious rites and ceremonies.

To quote from this Legend: "The people felt themselves weak and poor. Then the old men gathered together and said: Let us make our children cry to Wa-ka*n*-da. * * * So all the parents took their children, covered their faces with soft clay, and sent them forth to lonely places. * * * The old man said You shall go forth to cry to Wa-ka*n*-da. * * * When on the hills you shall not ask for any particular thing, * * * whatever is good that may Wa-ka*n*-da give. * * * Four days and nights upon the hills the youth shall pray, crying, and when he stops, shall wipe his tears with the palms of his hands, lift his wet hands to heaven, then lay them on the earth. * * * This was the people's first appeal to Wa-ka*n*-da. Since that time, twice in the year, * * * in the spring * * * and when the grass is yellow, * * * this prayer is said."

A study of this practice, as still found among the tribes, shows that the youth, who uttered his prayer during days and nights of fasting, was not only asking help from Wa-ka*n*-da, but was seeking a manifestation, in a vision, of the mysterious power. The form of this manifestation, which should come to him, he believed to be that to which he must appeal when in need of help. The symbol of this form, which the youth ever after carried with him, did not in itself possess the ability to help, but served as a credential by which the youth reminded the manifestation, be it of bird or beast, of the promise believed to have been received from it in the vision.

The dream and the vision were not the same; the dream of sleep came unsought in a natural way, while the manner in which the vision was striven for indicates an attempt to set aside and override natural conditions. The natural dream has exercised an influence in many ways, but it has not had the constructive force of the vision.

The cry to Wa-ka*n*-da was the outcome of 'thought' during the long barren period of primitive life. Whither this 'thought' had tended we have seen in its culmination in the ideas that all things were animated by the same continuous life and were related to each other. These generalizing ideas were not strictly in accord with the evidence of man's senses. The Indian could not help seeing the unmistakable difference between himself and all other objects. Nor could he help knowing that it was impossible for him to hold communication, as between man and man, with the animals, the Thunder, etc. The ancient thinkers and leaders met this difficulty by the rite of the vision, with its peculiar preparation. The youth was directed to strip off all decoration, to wear the scantiest of clothing, to deny his social instincts, and to go alone upon the hills, or into the depths of the forests; he was to weep as he chanted his

prayer, and await the failing of his bodily strength and the coming of the vision. In this vision he saw familar things under such new conditions that communication with them was possible; and his belief in the reality of his vision could not but reconcile the animistic idea with the normal evidence of the senses.

The psychological conditions favorable to a belief in the visions, and the ethical influence of the rite of fasting, in its results upon the individual and upon society, cannot be considered here, but the constructive power exercised by the religious societies, which had their rise in the vision, claims a moment's attention, as pertinent to our subject.

From the legend already quoted, as well as from customs still existing in these tribes, we learn that men who had had similar visions became affiliated into groups or societies, and acknowledged a sort of kinship on the basis of like visions. For instance, those who had seen the Bear or the Elk, formed the Bear or the Elk society, and those to whom had appeared the Water Creatures or the Thunder Beings, were gathered into similarly defined groups. Within these societies grew up an orderly arrangement or classification of the membership, the institution of initiatory rites, a prescribed ritual and the appointment of officers.

An important stage in the secular organization of the people was reached when the acceptance of Leaders—'men who took upon themselves the authority to govern and to preserve order'—came to pass. It would seem, from the evidence of traditions and rituals, that the establishment of these Leaders, which implied the segregation of the people into groups of followers, was of slow growth and attended with rivalries and warfare. During this formative period, the early Leaders appear to have used the popular belief in the supernatural to strengthen their authority, so that they came to be regarded as specially endowed, and the efficacy of their vision was thought to extend over all their followers. In this way the symbol of the Leader's vision grew to be recognized as sacred to his kindred, and was finally adopted as the sign or totem of a common kinship or clan. This being accomplished, the taboo was instituted as a simple and effectual reminder of the totem of the Leader, and of the mutual obligations and relations of the members of the clan, which were further emphasized by the adoption of a set of names for each clan, all of which referred to its totem. Among the Omahas and Ponkas these names are called ni-ki-a, that is, spoken by a chief. In the ni-ki-a name and the ceremonies attending its bestowal there is a twofold recognition, that of a natural ancestor and that of the supernatural manifestation of this ancestor's vision. We have already seen a similar acknowledgment of a dual source of authority, where, in the rituals, the chiefs and the animals of their visions are both invoked.

In the clan organization the totem came to be representative preeminently of kinship; and its sign, as we have noted, was placed upon the dead, that they might be recognized by their kindred in the other world, and led directly to their clan. The function of the totem was social, rather than individual; the Indian depended for his personal supernatural help upon his own special vision, and his clan totem in no way interfered with his entrance into any religious society.

The resemblance which exists between the rites and rituals of the religious societies, and those which hedge about the office of Chief and Soldier, and Herald, marks the influence the societies have exercised upon the development of the tribal structure.

The control of the Thunder people runs

like a thread through all the tribes of the Siouan group. The character of their vision was such as easily to win popular recognition as preeminently authoritative, and they seem to have been singularly dominant from the earliest time.*

The Thunder gentes had charge of, or took an important part in, all ceremonies which pertained to the preservation of tribal autonomy. To them belonged the rituals and the ceremonies which inducted the child into its rights within the gens and the tribe; the adoption of captives and strangers; and the ceremonial preparation of the tribal pipes, without which there could be no tribal ceremony or enforcement of order. They had charge also of the rites for the preservation of crops from the devastation of insects and marauders. These were some of the exclusive functions of the Thunder gentes; but the rites of the worship of Thunder itself, and the ceremonies pertaining to war, of which Thunder was the god, so to speak, were in charge of other than the Thunder gentes.

In the Omaha tribe the Sacred Tent of War was set apart for the rites and ceremonies connected with Thunder. It was pitched in front of the segment of the tribal circle occupied by the We-jinshte gens, its Keeper. It stood apart as a special lodge and was regarded with awe by the people. In it were kept the Sacred Shell (a large *Unio alatus*); the Wa-i*n* (a bird-shaped bundle of raw hide, containing the skins of certain birds believed to be associated with Thunder); the Pipes used in the ceremonies of war, and a Pole of cedar.

* The members of the Thunder society claim that at death they join the Thunder Beings, although they do not thereby lose their kinship rights in their clan in the other world, but an Indian born into a Thunder gens could not at his death join the Thunder Beings, unless they had appeared to him in his vision. The people believed that the voices of noted Thunder men who were dead could be heard in the mutterings of the approaching storm.

In the myths the cedar tree is spoken of as the particular abode of the Thunder Birds. The Thunder Beings had their village amid a forest of cedars, and the club of these mythical beings was of the same tree. Cedar leaves were put upon the War Pipe after it was filled, so that when it was lighted it was the aromatic smoke of the cedar that was offered to the Four Directions, the Zenith and the Nadir. The cedar Pole, representative of Thunder, was called Wa-ghdhe-ghe, which means the power to confer honors. This name refers to the custom which prescribed that all war parties should start from this Sacred Tent and on their return report to it; and that all honors, namely, the right to wear certain regalia indicative of a man's prowess in battle, should be ceremonially conferred in this Tent.*

The vital point, in the ceremony of conferring honors, was when the warrior, standing before the Wa-i*n*, and reciting his deeds of battle, at a sign from the Keeper, dropped a small stick upon the bundle. If the stick rested thereon it was believed to be held by the Birds, who thus attested to the truth of the warrior's claims. If it rolled off upon the ground it was the Birds who discarded it, because the man had spoken falsely. These Birds, representatives of Thunder, were the judges of a man's truthfulness, and rewarded him by honors, or punished him by disaster, even to the tearing out of his tongue by a lightning stroke.

Naturally, in course of time, those warrior chiefs, who by favor of Thunder had been successful in war, whose truthfulness had been attested by the Thunder Birds,

* All these regalia, which are graded in rank, refer to Thunder. In several of the tribes these are feathers of certain birds, worn in a particular manner; the peculiar painting of a man's face, body or weapons; and, as among the Osages, the tattooing of the body and arms with lines so drawn that, when the highest rank is attained, the tattooed figure will represent the Thunder bird in outline.

and who had received their regalia, began to assume for themselves some of the authority conceded by all to Thunder itself. A song belonging to a Dakota chief says, "When I speak, it is Thunder." Gradually the exercise of the punishing power was extended to social offences; as, for instance, a man whose persistent evil conduct threatened the internal peace of the gens or tribe, might suffer loss of property or even of life, his fate being determined by the warrior chiefs assembled at the Sacred Tent around the cedar Pole, the representative of the Thunder; the function of the chiefs thus becoming augmented by affiliation with the supernatural.

When the first Thunder was heard in the spring the ceremonial of the worship of Thunder took place at the Sacred Tent. The Wa-*in* was opened and the bird skins exposed; the Pipes were smoked, the ritual sung, and the cedar Pole anointed. No one participated in these rites, except members of those gentes whose totems were believed to be related to Thunder. Some of these totems were of creatures predatory in their habits, and therefore allied to the destructive lightning; others, like the eagle and the hawk, could soar to the very clouds, while the flying swallows heralded the approaching storm. This fancied kinship of their totems was the basis of recognition of a sort of relationship between the gentes themselves, which became the ground upon which these people united in the performance of ceremonies directed toward a common object of worship.

Although important steps had been gained in social development, none of the rites and ceremonies of the Sacred Tent of War tended to bind all the gentes together, but the Omaha ceremony of the He-di-wa-chi seems to have been adapted to meet this requirement. It is impossible to state as a fact that the He-di-wa-chi grew out of the experience of the people during the centuries when they were being slowly driven by wars, farther and farther from their eastern home; but, according to traditions preserved in the different tribes, it was during this period that group after group parted company, and the enfeebled bands became a tempting prey to active enemies. Nor was the danger always from without; disintegration sometimes resulted from the rivalry of ambitious Leaders, and, to quote from the tradition, "the wise men thought how they might devise some plan, by which all might live and move together and there be no danger of quarrels."

Many points in its ceremonial indicate that at the time of the institution of the He-di-wa-chi the people had entered upon agricultural pursuits, and were not wholly dominated by those ideas which had been the controlling power when hunting and war were the principal avocations. The He-di-wa-chi took place in the summer solstice, or, according to Indian designation, at 'the time when all the creatures were awake and out.' The choice of the tree from which the Pole, the central object in this ceremony, was to be cut, is significant. It was either the cottonwood or the willow, both remarkably tenacious of life, sending forth shoots even when cut down and hacked into posts. In the Indian's words describing the time when this ceremony was to take place, we catch a glimpse of a shadowy idea of peace, for when danger stalked abroad the animals which were 'awake' would not be 'out' but in hiding; and in the choice of the tree with its abounding life we note the beginning of an apprehension of the idea of the conservation of life. This helps us to open out and understand the terse and poetic expression of the Indian tradition concerning the ceremony, that 'it grew up with the corn.' The ideas embodied in this festival found their birth and growth in the cultivation of the maize, which held the people to their

fields, preventing their constant wandering after the wild animals, and so inaugurating village life and developing an appreciation of tribal unity.

The first act in the preparation of this ceremony was the cutting, by the Leader having it in charge, of seven cottonwood or willow sticks which were stripped of leaves, with the exception of a small spray at the end, thus making a miniature pole. These were sent to the chiefs of the seven original gentes, who, in their turn, sent out the men of their gentes to cut similar sticks, which were to be painted red and carried in the great tribal dance about the Pole.

While this was being done, the Leader selected runners to represent warriors, who were to go out, as a scouting party would go in search of an enemy, and when they found the tree which was to be cut for the Pole they were to charge upon it and strike it as they would strike a foe. In this ceremony of selection, where war is so simulated, the recognition of the power and authority of Thunder is manifest, for no man could become a warrior except through his consecration to Thunder, the god of war. Moreover, it was believed that no man could fall in battle through human agency alone; he fell because Thunder had designated him to fall. So the tree, which had been struck as a foe, fell because Thunder had selected it. The tree thus chosen was now approached by the Leader, who said, "I have come for you that you may see the people, who are beautiful to behold." Then with elaborate ceremonies, in which the Four Directions were recognized, the tree was cut down; the bark and branches, all but a tuft at the top, were removed and buried at the foot of the stump, and the Pole, with much ceremony, was carried to the camp, where it was painted by the Leader in alternate bands of red and black, symbolic of Life and of Thunder. When this was done the Leader said, "It is finished; raise him up that your Grandfather (*i. e.*, Thunder) may see him."* The Pole then, being placed in position in a hole prepared for it, stood before the people as approved by the ancient Thunder Beings. Then the Herald went forth to call the people to make ready to welcome the Pole with dancing and gifts.

Now the camp is astir with preparation; every one dons his gala dress and hastens to take his place with his gens in the tribal order, forming an immense circle around the Pole. The singers, seated at the foot of the Pole, strike up the first of the ritual songs; at its close the war cry is given by all the people, who then advance a short distance and halt. Four times the song is sung, four times the cry is given, four times the people advance and halt, and at the last pause they are near the Pole. At this point the men of the In-ke-tha-ba gens, led by two pipe bearers, face about to the west, their right side to the Pole, and the women face to the east, with their left to the Pole. Each of the other gentes falls into like order behind the In-ke-tha-ba men and women, and when the second ritual song is begun the entire double circle begins to dance around the Pole. During the dance four halts are made, and at these halts if any dancer has passed beyond the line of his gens he must return to it. The songs become more and more rapid in measure and the dance fuller of mirth and gaiety. At the close of the ceremony the men, women and children throw their sticks at the foot of the Pole, to which they are tied and left for the sun and wind to dispose of.

The manner in which the Pole was approached by the whole people in the order of the tribal circle, with war cry and charge, was a recognition of the victories gained through the war god, Thunder. The entire ceremony was a dramatic teaching, to old and young, of the necessity of union

* These words, in the original, are of the nature of an invocation and consecration.

not only for defence, but for the preservation of internal peace and order, in the security of which industry might thrive and prosperity be within the reach of all.

The He-di-wa-chi, all the details of which cannot here be described, is a festivity of joy; the words of the opening song are, 'Come and rejoice!' The whole scene vibrates with color and motion; there is no hint of sacrifice; the Thunder selected tree is a symbol of Life, held in the fruitful grasp of the earth, and touched by the beneficent rays of the sun.

The so-called Sun Dance of the Dakotas and Ponkas seems to have sprung from the same parent stem that bore the He-di-wa-chi; but it shows marks of the influence of tribal environment during the past few centuries, as well as traces of contact with other stocks. For a considerable period prior to our first knowledge of the Dakotas, these tribes had dwelt in the most northern range of the Siouan linguistic stock, and had almost lost their knowledge of the cultivation of corn. Omaha traditions say that their own tribe turned back from the region where the Dakotas were when first discovered by us, because corn would not grow well there, and they sought sites for their villages farther south, where they could raise the maize in large and unfailing crops.

The Sun Dance and the He-di-wa-chi have fundamental features in common. They take place at the same time of the year; both Poles are cut from the cottonwood or the willow tree; the ceremonies attending the cutting and planting and decorating the Poles are practically the same, differing only in the elaboration of detail. Both are consecrated by and to Thunder, and about both the tribe must gather in the order of the gentes. The special rites of the Sun Dance are performed within a communal tabernacle erected about the Pole. It is made of one or more poles gathered from the tent of each family in the tribe, and covered with green branches. It represents the living branches of the tree, as well as the great congregation of the people, whose tents enclose it in a circle, often more than a mile in circumference.

The elaborate character of this ceremony precludes the mention of any of its parts, except those which pertain to the subject of this paper.

The symbol placed upon the buffalo skull, and drawn upon the U-ma-ni—a space of ground from which the sod had been removed, and the earth made fine—is a circle with four projecting points equidistant from each other. This symbol, to quote from Dakota Indians who had been instructed in this ceremony, "represents the tribe and the Four Directions. It means that wherever the tribe may travel it will be kept whole. Its circle of tents will not be broken, the members of the tribe shall live long and increase. The symbol also stands for the earth and the unseen winds that come from the Four Directions and cross over the earth and bring health and strength." The people were told that "as long as they observed the ceremony they would increase and grow strong, but if they should neglect the rite they would decrease in numbers, lose their strength and be overpowered by their enemies."

The dramatic character of the adjuncts of self sacrifice and torture has diverted the attention of observers from the true purpose of the Sun Dance, which has been clouded in the minds of the people themselves, but has not been lost sight of by the Indian priests, who still insist that the ceremony is necessary to the preservation of the people as a tribe.

The torture practised at the Pole seems to be a transference, to this ceremony, of the ancient rite known as Hanm-de-pi, where the man suspends himself while seeking a vision through fasting; or when, fixing his mind upon a particular desire, he expects

through torture to render its accomplishment certain. Even in the Hanm-de-pi there are indications of foreign influence which tended not only to keep alive, but to intensify the more primitive forms connected with Thunder worship—forms which had almost died out in the more southern tribes, surviving only in certain modified rites observed in mourning for the dead and the leading of a war party.

In the absence of agricultural avocations and their attendant corn ceremonies, the belief that the Pole was selected and consecrated by Thunder came to be more and more pronounced, as is indicated by the fact that the Thunder men only could take charge of the Sun Dance, whereas, in the He-di-wa-chi it was the red corn people who were the Keepers of the ritual and Leaders of the ceremony. It is easy to see how, through the influence of Thunder, originally represented in the consecration of the Pole and augmented by the dominance of the Thunder men, the torture rites came to be grafted upon the ceremony, which, owing to environment, had lost something of its early significance.

When witnessing the Sun Dance its composite character was impressed upon me, and the lack of unity between the parts was evident. Further study has shown how different rites have been united, and what are some of the influences which have brought about this grouping.

The Dah-pi-ke or Nah-pi-ke of the Hidatsas resembles the Sun Dance. It takes place at the same season of the year. The Cottonwood Pole is selected and cut with similar ceremonies; about it the communal tabernacle of willow boughs is erected, and all the people must gather to the rites. Like the Sun Dance, it bears evidence of the same influences, which have overlaid a tribal ceremony 'that grew up with the corn,' with those other rites wherein self torture was practiced.

As in the He-di-wa-chi, the tree or Pole of the Sun Dance, and of the Dah-pi-ke, is left at the close of the ceremony to the destruction of the elements, or powers, to which, in the mind of the people, it belonged.

In the Sacred Pole of the Omaha tribe we have another off-shoot from the same parent stem. In its rites, however, the fundamental ideas embodied in the ceremonies already considered have been still further developed and specialized. The selection of the Pole, its cutting, decoration, etc., the season when its ceremonies took place, and the compulsory attendance of the people, were all practically the same as in the He-di-wa-chi, the Sun Dance and the Dah-pi-ke.

In a paper read before this Section last year the Sacred Pole was described. Your attention at this time will be called only to a peculiar function in reference to the tribal autonomy.

A tradition in the tribe says: "At one time the seven original bands wandered about independent of each other; each band had a pipe and a leader. The Hungagens thought that if this continued there would be fueds between the bands.* * * So the Sacred Pole was made, around which the different bands might gather. The seven chiefs were called together, and they all united and have been so ever since." The Legend corroborates the tradition, for it says: "The ceremonies of the Sacred Pole was devised to hold the people together."

The institution of the Sacred Pole marked a political change in the tribe, from the government by hereditary chieftians to an oligarchy of the seven chiefs who attained their position by personal ability to perform certain deeds, called Wa-dhin-e-dhe. The name of the old cedar Pole of the Sacred Tent of War, Wa-ghdhe-ghe, which, as we have seen, meant 'the power to bestow honors,' was given to the new Sacred Pole,

which became the fount of honors won in peace, for the Wa-dhin-e-dhe were not deeds of war; for their achievement, industry and accumulation of property, as well as valor, were required. So also, whereas the honors, bestowed in the Sacred Tent of War, were worn by the warrior himself, or tattooed upon his own body, as ghdhe-ghe, or mark of honor authorized by the power represented in the Sacred Pole, was placed upon the daughter of the successful aspirant, the woman being the industrial factor in the tribe. The mark of honor consisted of two symbols; upon the forehead of the girl was tattooed a small round spot representing the sun, and upon her chest and back a circle with four equidistant points; the same symbol that was made upon the earth and the buffalo skull in the Sun Dance, and bearing the same idea, of strength in unity.

The seven chiefs who formed the oligarchy must act as one man, for without unanimity in their councils nothing could be done. In their decisions all the seven men must be alike represented, and the resultant unity was believed to be derived from Wa-ka*n*-da, present in and acting through the mysterious Sacred Pole. To quote from the Legend: "The chiefs are slow to speak, * * * no word is without meaning, and every word is uttered in soberness, * * * believing the words come from Wa-ka*n*-da, so the words of a chief are few. They (the seven chiefs) have all one heart and one mouth * * * After a question is decided, the Herald proclaims it about the camp circle, * * * none of the people dare dispute it, for they say, It is the word of our Chiefs."

The two avocations upon which the life of the people depended were agriculture and hunting, and these were controlled by the ceremonies of the Sacred Pole. From the Pole was decided the time for planting the corn, and about it the ritual of the maize was sung. The great tribal hunt was under its immediate direction, the rules and regulations of which were an important part of its function. On this annual hunt the people left their village and their fields in care of a small guard and followed the herds, under the strict control of the Chiefs and of a body of men called Soldiers. During the entire time, two months or more, the rights and inclinations of the individual were held rigidly subordinate to the good of the tribe. The Sacred Pole was carried in advance of the people, as they moved from camp to camp. From its presence the runners went forth in search of the buffalo, and to it they reported upon their return. At the close of the hunt the ceremony of thanksgiving and anointing the Pole took place, when the entire tribe gathered about this central object, erecting a communal tent for some of the particular ceremonies and offering gifts. Finally, the men enacted before it the events of their career, thus presenting a sort of dramatic current history of the tribe.

At the inauguration of the Pole and its ceremonies, to quote from the Legend: "The Leader said, this (the Pole) belongs to all the people, but it shall be in the keeping of one family." For over two centuries this Sacred Pole was preserved, and its tent was pitched a short distance in front of the segment of the tribal circle occupied by a subdivisionn of the Hu*n*-gagens, its Keepers. It was regarded with fear and reverence, as the supernatural protector of the people, as the power that insured to them an abundant supply of food, and commanded the coordination of the gentes and the unification of the authority of the Chiefs.

In all these rapidly considered ceremonies, marking periods in social development of this group of tribes—development more or less modified by shifting environments—

we note the constructive force of the religious ideas of the people; ideas which, represented by the word Wa-ka*n*-da and its kindred terms, imply the existence of an ever active, mysterious power, permeating all nature, including mankind, with the same life, thus making all things related and anthropomorphic. We have seen how these generalizing ideas become concrete, through the medium of the vision, and capable of exercising a practical, formative influence. We have traced this practical, formative influence in the unifying power of the totem, which welds together an extended though partial kinship within the clan or gens. We have seen it also operative in the religious societies, where an indestructible bond holds the members together upon a basis other than that of blood relationship. The same influence has been found at work in the association of certain clans for a common worship, the tie of their association being a supposed relationship of their separate totems to Thunder, the object of their worship. We note also that the authority of Thunder was still further extended so as to embrace the entire tribe, inasmuch as every man was brought under its control through the rites and ceremonies connected with war. Furthermore, we discern that out of the ancient ceremonies connected with Thunder, wherein primarily the cedar tree was the mythical abode of the mystical Thunder Beings, and later, the cedar Pole stood as emblematic of their power and authority, were evolved the ceremonies that made use of the old symbols, but clothed them with ideas born of newer conditions.

In the He-di-wa-chi has been found preserved the outline of one of the simplest and probably oldest ceremonies instituted to draw the people together and unite them into an organized body. And it is apparent that the Sun Dance, the Dah-pi-ke, and the Omaha Sacred Pole, from the same root, kept the same fundamental aim in view, performing their ceremonies about the same central object, the tree or Pole, selected and consecrated by the all-powerful Thunder, recognized as the judge and rewarder of all the people. We have seen the Chiefs summoned to the He-di-wa-chi by a tree stick, sent from the Keeper of the ceremony, each Chief in turn sending forth the men of his gens to gather each man sticks for himself and family, and all the people assembled and dancing about the Pole by gentes, each one carrying his stick, which at the end of the ceremony was given back to the Pole. A simple object lesson: to teach that the tribe was, like the tree, animated by the supernatural mysterious power; and that the Chiefs were its strong limbs, upon which the smaller branches grew.

In the Sacred Pole ceremonies, the constructive idea was still further developed, until not only unity of gentes was required, but unity of authority among the Chiefs was enforced. This unity, whether as demanded in the enunciations of the Chiefs, or, as necessary to the formation of the tribe, to the instituting of the religious societies, or to the development of the clan, depended upon the conception of Wa-ka*n*-da, as manifested in concrete form through the medium of the Vision. The ancient thinkers among the Siouan people, in the long centuries of an unknown past, came gradually to realize the helpfulness and power that lay in social unity. Out of this realization these ceremonies were slowly evolved, wherein the Pole, bearing the topmost branches of the living tree, stood in the midst of the assembled people, as an emblem of the presence and authority of Thunder, the universally accepted manifestation of Wa-ka*n*-da, and also, in its life and growth, as typical of tribal unity and strength.

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CURRENT NOTES ON ANTHROPOLOGY.

AMERICAN LINGUISTICS.

STUDENTS of the ethnography of the Northwest Coast will welcome the 'Haida Grammar,' written by the Rev. C. Harrison and edited by Dr. A. F. Chamberlain. It is published in the Transactions of the Royal Society of Canada (Second Series, Vol. I.), and covers 108 octavo pages. It is based on the scheme of grammars of Aryan tongues, the same grammatical categories being applied to the Haida. While this offers no special difficulty to one versed in the morphology of American idioms, it certainly presents such tongues under false analogies, which have often misled tyros in their study. It would have been better if the highly competent editor had taken the material and recast it in the form now required by linguistic science.

Dr. Paul Ehrenreich has added another to his valuable studies of Brazilian languages by publishing in the *Bastian Festschrift* several old vocabularies and a list of phrases of the tongue of the Botocudos. The analysis of them and the grammatical remarks which he adds give largely increased value to these fragments. His paper is entitled 'Ein Beitrag zur Charakteristik der Botocudischen Sprache.'

PRIMITIVE PSYCHOLOGY.

To the primitive man, as we know him, the sense of individual power, that which metaphysicians call 'free will,' was very present. The strong, the mighty, was what excited his admiration above all else. His ideal was the man who could do what he wished or willed to do. The savage acknowledges no theoretic limit to the will any more than does the religious enthusiast. It can move mountains and consume rivers. It can act at indefinite distances and its force is measureless. In the religion of ancient Egypt the highest gods could be made to serve the will of a man, did he but use the proper formula of command.

An interesting study of these aspects of savage psychology was read by Miss Alice C. Fletcher before the American Association. It is entitled 'Notes of certain beliefs concerning will power among the Siouan Tribes.' The author sets forth the strong sense of personality characteristic of the tribe and its language, though by no means confined to them, analyzes a series of terms employed to express the exercise of the power of volition, and explains a number of curious rites and customs which have sprung from the beliefs held by the Siouan gentes on this subject.

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CURRENT NOTES ON METEOROLOGY.

A TORNADO IN ARGENTINA.

A LARGE quarto of 556 pages is Vol. X (for 1891) of the *Anales de la Oficina Meteorologica Argentina* (Buenos Aires, 1896). It contains annual summaries for the principal stations and a general account of the year's work by the director, W. G. Davis. The most notable meteorological phenomenon of the year was a tornado, which occurred on November 13th, at Arroyo-Seco, situated on the railroad from Buenos Aires to Rosario, 19 miles from Rosario. Ten persons were killed, and more than 80 wounded, and of 50 or 60 houses in the town only 5 were left intact. The atmospheric conditions preceding the tornado, its progression and its destructive force, all resembled the similar features familiar here in the United States in connection with our own tornadoes. The day had been very hot, and just before the occurrence of the tornado the air was suffocating. The movement was from southwest to northeast. One freight car, weighing over 30,000 pounds, was carried a distance of 98 feet from the railroad track. Calculations as to the force of the wind,

based on all available data, give a maximum pressure of 125 pounds per square foot. The direction of the whirl is stated to have been from *right* to *left*. As this tornado occurred in the southern hemisphere we should have expected a movement from *left* to *right*. Perhaps this whirl is described as if it were looked at from the outside, and not, as we are accustomed to describe our whirls, as if we stood at the center and looked out at the circulating winds. If the former is the case, then the *right* to *left* in the published account would mean *left* to *right* from our point of view, and the Arroyo-Seco tornado would follow the general rule. Or, it may be that this tornado was one of the very rare exceptions and really whirled in the northern hemisphere fashion, instead of following the fashion of its own hemisphere.

A view of the damage done by this tornado was published in Vol. X. of the *American Meteorological Journal* (opp. p. 350), and is interesting from the fact that the original view is probably the only photograph of a southern hemisphere tornado ever taken.

ATMOSPHERIC DUST OBSERVATIONS.

ONE of the many interesting branches of the new meteorology is the study of the number of dust particles in the atmosphere, and of their effect in causing the condensation of water vapor in clouds, fog, rain or snow. Aitken's papers in this connection, published in the Proceedings of the Royal Society of Edinburgh, have made this subject more or less familiar to all scientific men, but comparatively little use has as yet been made of his Dust Counter by others than the inventor, although much important work can undoubtedly be done along the lines suggested and followed by him. In a recent paper on *Atmospheric Dust Observations from Various Parts of the World* (Quart. Journ. Roy. Met. Soc., July, 1896), Fridlander gives many interesting results obtained by him with an Aitken Pocket Dust Counter during a voyage around the world. Space permits mention of only a few of the most striking facts. The average number of dust particles per cu. cm. of air over the Pacific Ocean during eight days was 540, while, when the vessel was about 350 miles from Auckland, the number rose to 1229, and when about 15 miles from the Great Barrier Island it was 1972. The average dustiness of the Pacific was 613, and that of the North Island of New Zealand, together with the polluted area outside of it, 1336.

The clearing effects produced by fog are plainly seen in the following summary, based on many tests made on the Atlantic, the Pacific and the Mediterranean:

No. of particles per cu. cm.	Condition of air.
2000	Foggy at intervals.
3000	Thick fog.
420	Half hour after clearing of fog.
3120	Thick fog.
280	Clear region just beyond fog.
1550	Region farther out of fog.

The lowest figures obtained by the author, 210, were found on the Indian Ocean after much rain, and on another occasion the number of dust particles at 10.30 a. m. was 331, while at 11 a. m., after a shower, it was 280. The purifying effects of rain are thus clearly seen.

It is a cause for regret that there is not a large number of investigators in the United States working on this interesting subject of atmospheric dust. So far as we know, there are but two of Aitken's dust counters in this country.

RECENT KITE-FLYING AT BLUE HILL OBSERVATORY.

THE exploration of the free air by means of self-recording instruments elevated by kites has been greatly advanced during the present summer through the work done at Blue Hill Observatory, 640 feet above sea level, near Boston. The kites used are the

Eddy, or tailless, and the Hargrave, or box kites, and the instrument sent up with them is the aluminum baro-hygro-thermograph, constructed for Mr. Rotch, proprietor of the observatory, by Richard *freres*, of Paris. The altitudes reached are determined in three distinct ways: by theodolites, by the angle and length of the kite-line, and by the pressure as recorded by the barograph. During the summer of 1895 the maximum altitude reached by the instrument in the kite-flying at Blue Hill was 2,500 ft. above sea level, but this has been far exceeded during the present year, the height of one mile having been passed on six occasions. On July 20th a height of 6,596 feet above sea level was reached. At a short distance above the earth a cloud was encountered, in which the relative humidity rose to 100%, while after a further ascent of about 2,500 feet, which must have been the thickness of the cloud, the air was found to be much drier.

All kite-flying records were broken on August 1st, when the recording instrument was raised to a height of 7,333 feet above sea level, or considerably over a mile above the general level of the country. Five Eddy kites were used. The temperature at the maximum altitude was 20° less than at the observatory, and the records of the relative humidity aloft showed variations of from 30% to 80%.

Scientific kite-flying, although one of the very newest developments of meteorology, has now passed the experimental stage, and the results obtained from these investigations at Blue Hill are attracting attention the world over. R. DeC. Ward.

Harvard University.

SCIENTIFIC NOTES AND NEWS.

A BRITISH NATIONAL PHYSICAL LABORATORY.

At the recent meeting of the British Association Sir Douglas Galton read the report of the committee on the establishment of a national physical laboratory. This report enumerated the present facilities afforded by the government, by educational establishments and by private societies, for aiding research in Great Britain. These sources are chiefly the £4,000 per annum given by the government for research purposes and administered by the Royal Society; the Royal Society donation fund, derived from its surplus income; the contributions made to research by the British Association; the investigations carried on at the Royal Institution, which afford magnificent examples of private munificence in aiding science; the City and Guilds of London Institute; the Royal Commission of the 1851 Exhibition, which devotes £6,000 a year to research scholarships; research committees of various scientific societies; the Clarendon Laboratory at Oxford and the Cavendish Laboratory at Cambridge; the laboratories at Edinburgh, Glasgow and Aberdeen; the Victoria University and the larger colleges not yet incorporated into universities. There were, however, investigations of particular types which lay outside the range of effort possible either to an individual or to a great teaching institution. These were (1) observations of natural phenomena, the study of which must be prolonged through periods of time longer than the average duration of life; (2) testing and verification of physical instruments and preservation of standards; (3) the systematic and accurate determination of physical constants and numerical data which may be useful either for scientific or industrial purposes. A laboratory for such purposes would aid and not compete with laboratories for more general physical research, and if England was to keep pace with other countries it was essential that it should be started and maintained by government. After detailing the functions and management of the proposed new institution on lines similar to those of the very successful German Reichsanstalt, the report recommended that government should be asked to vote a sum of £20,000 to £25,000 for building and an annual grant of £3,000 for maintaining such a national laboratory. An appendix gave the cost and annual expenses of the German institution, which amounted to £200,000 and £15,000 respectively.

RECENT GEOGRAPHICAL EXPLORATIONS.

IN an introduction to his address as President to the Geographical Section of the British Association, Major Darwin summarized recent geographic work, referring first to the feat accomplished by Nansen. It is not merely that he has gone considerably nearer the North Pole than any other explorer; it is not only that he has made one of the most courageous expeditions ever recorded, but he has established the truth of his theory of Polar currents, and has brought back a mass of valuable scientific information. Besides the news of this most remarkable achievement, the results of a considerable amount of useful exploratory work have been published since the British Association met last at Ipswich. With regard to other Arctic Expeditions, we have had the account of Lieutenant Peary's third season in Northern Greenland, from which place he came back in September last, and to which he has again returned, though without the intention of passing another winter there. In October the Windward brought home more ample information as to the progress of the Jackson-Harmsworth Expedition than that communicated by telegram to the Association at Ipswich, and on her return from her remarkably rapid voyage this summer she brought back the record of another year. As to geographical work in Asia, Mr. and Mrs. Littledale returned safely from their explorations of the little known parts of Thibet; the Pamir Boundery Commission under Colonel Holdich has collected a great deal of accurate topographical information in the course of its labors; Dr. Sven Hedin continues his important researches in Turkestan; and the Royal Geographical Society was glad to welcome Prince Henry of Orleans when he came to tell about his journey near the sources of the Irrawaddy. As to Africa, the most important additions to our knowledge of that continent are due to the French surveyors, who have accurately mapped the recently discovered series of lakes in the neighborhood of Timbuktu, Lake Faguibine, the largest, being found to be 68 miles in length; Dr. Donaldson Smith has filled up some large blanks in the map of Somaliland; and Mr. and Mrs. Theodore Bent have investigated some interesting remains of ancient gold workings inland of the Red Sea. In other parts of the world less has been done, because there is less to do. Mr. Fitzgerald has proved for the first time the practicable character of a pass across the Southern Alps, thus supplementing the excellent work of Mr. Harper and other pioneers of the New Zealand Alpine Club; and Sir W. M. Conway has commenced a systematic exploration of the interior of Spitzbergen, a region to which the attention of several other geographers is also directed.

THE UNIVERSITY SCIENTIFIC MAGAZINE.

THE universities and technical colleges have, of late years, been publishing scientific magazines under the auspices of and sometimes directly by, their scientific and technical college departments. In most cases they are conducted and managed by students as private ventures, but usually securing a considerable proportion of their contributions from members of the college faculty and from the alumni; in some instances they are controlled wholly by members of the faculty or the alumni.

There has just come to hand a copy of the *University Scientific Magazine*, published by the Engineering Society of the University of Tennessee, at Knoxville. This is a good example of the class. It contains, within the compass of about forty pages, a number of valuable articles, interesting both as original contributions to science, and as exhibiting the progress of scientific work at that institution and in this field.

Dr. Perkins discusses the experimental work of Hertz on the electro-magnetic theory of light. Prof. Wait takes up the distribution of titanium, which he finds in vegetable ash, and, in another article, the oxidation of silver by lead-oxide. An excellent biographical sketch of Dr. Perkins, with a good portrait, add variety and interest to the issue. A note by Giddersleeve on the zinc deposits of Tennessee gives an excellent idea of the extent and importance of the mineral deposits of the State and indicate that it may become an important zinc-producer. The report on a test of an isolated gas engine electric lighting plant shows the character of the work in engineering. It shows further that, for

above 30 lamps, the gas may be profitably burned in the gas-engine. Mr. Reynders gives an account of experiments with a differential Watt-meter indicating the probably frequent existence of errors in such work. Mr. Ferris makes a valuable contribution to the draughtsman's department in a collection of alphabets, for use in marking drawings with the pen, which have special value as illustrating the practice of a number of distinguished and successful manufacturing and other firms, whose draughtsmen have reduced the production of such alphabets to a most efficient state.

There are few phases of modern scientific and technical college work which have better exhibited the progress made on that side of education, in the last decade or two, than the appearance and progress of these scientific journals. Each measures, in greater or less degree, the standing of its source of publication; although, as a matter of course, care must be taken to distinguish between the periodicals published by students and those issued more formally and under the more practiced hands of professors and alumni. R. H. T.

INORGANIC CHEMISTRY.

PROF. OLSZEWSKI has published in the Bull. Acad. Sci. de Cracovie for June an account of his unsuccessful attempts to liquefy helium, and a translation of the paper is given in *Nature* of August 20th. In the first experiment the helium was cooled by liquid oxygen boiling at 10 mm. pressure; in the second by liquid air under the same conditions. At the temperature of — 210° and 140 atmospheres pressure no sign of condensation occurred, and on allowing the gas to expand until the pressure was reduced to twenty atmospheres and in some cases to one atmosphere, the gas remained perfectly clear, and not the slightest trace of liquid could be detected. Prof. Olszewski calculates the temperature reached by this expansion to be — 263.9° and that therefore the boiling point of helium is at least 20° lower than that of hydrogen. He also points out that helium is an ideal gas for a gas thermometer for very low temperatures.

IN the *Chemical News* Profs. Ramsay and Collie describe their attempts to separate argon and helium into two parts by fractional diffusion through porous pipe clay. In the case of argon the heaviest fraction gave a density of 20.01 and the lightest 19.93, showing the apparent homogeneity of the gas. In the case of helium the density of the gas first passing was 1.874 and of the gas remaining in the apparatus was 2.133. Repeated fractionations did not change these figures. From this it would appear that helium contains two constituents with densities respectively 2.366 and 1.874 or of 2.133 and 1.580, according as the lighter or the heavier fraction is the mixture. The spectrum of both gases was the same, and the revolutionary question is raised as to whether all the molecules of an elemental gas necessarily have the same weight.

DR. A. ANGELI has described in a recent number of the *Gazetta Chimica Italiana* salts of a new oxyacid of nitrogen of the formula $H_2N_2O_3$, formed by the action of ethyl nitrate on an alchoholic solution of free hydroxylamin. The sodium and the barium salts are fairly stable when dry, but in solution decompose readily on boiling with evolution of nitrogen monoxid. The same gas is given off when solutions of the salts are treated with acids. The acid appears to be a nitro-hydroxylamin (NH. OH. NO_2), but is bibasic, the sodium salt having the formula $Na_2N_2O_3$. This compound possesses considerable interest from a theoretical standpoint, in view of the great extension in recent years of the chemistry of nitrogen in its combinations with hydrogen and oxygen. J. L. H.

GENERAL.

THE British Association has approved the recommendation of the Council that on the occasion of the meeting of the Association at Toronto the President, Vice-Presidents and officers of the American Asssciation be invited to attend as honorary members for the year, and, further, that all fellows and members of the American Association be admitted members of the British Association on the same terms as old annual members—namely, on payment of £1, without the payment of an admission fee.

THE ninth annual meeting of the Geological Society of America will be held in Washington, December 29-31, 1896. It is announced that

details of the meeting will be communicated to the fellows of the Society in a circular to be issued about November 1st.

DR. J. WALTER FEWKES, of the Bureau of American Ethnology, has just returned from a remarkably successful collecting season in New Mexico and Arizona. Three ancient villages (Homolobi, Chevlon and Chaves) were explored and extensive excavations were made, more than fifty boxes of pottery and other relics being brought to light and shipped to the National Museum. The collection is remarkably rich, not only in the number of pieces, but in the high grade of the ware and the elaborate symbolic decoration painted on most of the vessels. Dr. Fewkes' collection of last year, in the same region, was the finest ever made in America up to that date; yet this year's collection is twice as large and no less instructive in its symbolism and associations.

THE Public Works Department of the Government of Bengal has just issued a most valuable 'List of Ancient Monuments in Bengal, revised and corrected up to August 31st, 1895' (Calcutta). The particulars given are the name of the monument, the district and locality in which it is placed, the history or tradition regarding it, its custody or present use, its state of preservation, and suggestions for its conservation and references to particulars describing the monument.

MR. A. TREVOR BATTYE has arrived in England after his explorations of Spitzbergen. He believes that the crossing of Spitzbergen by Sir Conway Martin will lead to great saving of life, because a route has now been laid down by which a crossing may be effected in a few days to the west, where the water always opens early in the summer. This point is Advent Bay, where a wooden house has lately been erected, in which it is hoped supplies of food may be kept against future emergencies.

Nature states that it was announced, at a banquet given to Dr. Nansen, September 10th, that a Nansen fund had been formed for the advancement of science. Subscriptions to the amount of 210,000 kroners had already been received.

CAPT. PEARY has telegraphed to the New York *Sun* a detailed account of his expedition on the steamship 'Hope,' which arrived at North Sydney, Cape Breton, on September 26th. The trip was without special event. It was not found possible to secure the large meteorite, as the apparatus was broken in the attempt to dislodge it from the frozen ground. Of the scientific parties, that under Prof. R. S. Tarr was landed at Melville Bay, that of Prof. George H. Barton near Disco Island, and that of Prof. Alfred Burton at Omanak, and accomplished the scientific work that they had planned. The contents of over a hundred cases will, through the interest of its President, Mr. Morris K. Jesup, enrich the collections of the American Museum of Natural History with much valuable material. The past winter in Greenland has been one of unusual severity, and the summer has been marked by much wind and an unusual amount of exceptionally heavy ice, particularly along the west side.

IT is reported in the daily papers that Dr. Lewis Swift, of Echo Mountain, Cal., discovered on September 20th a small, bright comet near the sun, one degree east of it. On September 21st the object was north of the sun and fainter.

THE French Congress of Medicine will be held at Montpellier in 1898, during the Easter holidays, under the Presidency of Prof. Bernheim, of Nancy. The annual Congress of French Alienists and Neurologists will be held at Toulouse in 1897.

SIR JOHN ERIC ERICKSEN died at Folkestone on September 23d at the age of seventy-eight years. Ericksen was an eminent English surgeon and the author of many works on surgery and physiology. He was at the time of his death emeritus professor of surgery and consulting surgeon to University Hospital, a fellow of the Royal Society and many other scientific and medical associations and had been President of the Royal College of Surgeons.

A DESPATCH from Jiminez, Mex., says that Emile Renbaugh, a German naturalist, who had been spending the summer in the Sierra Madre Mountains, has been killed by accidentally falling from a cliff.

GEORGE F. H. MARKOE, a chemist and pro-

fessor in the Massachusetts College of Pharmacy, has died at Boston.

THE late Enoch Pratt has made the Shepherd Asylum for the Insane at Baltimore his residuary legatee provided that it should change its name to the Enoch Pratt Hospital. The bequest is valued at $3,000,000.

THE will of the Rev. Lucius R. Page of Cambridge, Mass., leaves $2,000 to Tufts' College for the foundation of a scholarship and $10,000 to the town of Harwich for the establishment of a public library, to which his library and collection will be given on the death of his widow.

THE *Journal of Physical Chemistry*, whose establishment under the auspices of Cornell University we recently announced, will be supported by a gift from Mr. E. G. Wyckoff of $1,000 a year for five years.

AFTER an interval of four years the American Institute Fair will be held in the Madison Square Garden, New York, on September 28th. A large amount of machinery and a number of technical processes will be exhibited in operation.

PROF. FUERTES, Director of the College of Civil Engineering at Cornell University, is in correspondence with the Spanish authorities in Cuba, having been asked to take into consideration plans for improving the sanitary condition of Havana.

THE Paris Academy of Moral and Political Sciences has awarded the Bordin prize of 2,000 fr., the subject for which was this year Kant's Ethics, to M. Cresson, professor at Besançon.

GINN & Co. announce for publication this fall a 'Star Atlas,' by Winslow Upton, professor of astronomy and Director of the Ladd Observatory, Brown University.

Two parts of the extensive *Handbuch der Anatomie des Menschen*, edited by Prof. Karl von Bardeleben, have now been issued by Gustav Fischer. The first part of the first volume, chiefly concerned with the spinal column and containing 92 pages and 69 illustrations, is by Prof. J. Disse. The work will be completed in eight large volumes.

THE Report of the Commissioner of Education for 1893–4 gives interesting statistics concerning the number of books and manuscripts in the university libraries of Europe. Germany stands first, its twenty libraries containing as many as 5,850,000 volumes, over 3,000,000 more than the libraries of Italy, which takes the second place. Great Britain, Austria and Russia have each more than 1,800,000 volumes, Sweden and Norway and Spain have 790,000 and 726,000 respectively. It is worthy of note that, of the eight countries where statistics have been collected, France, which in the number (sixteen) of its libraries surpasses every other country, Germany and Italy excepted, should have the smallest total number of books (692,200 volumes), the largest library (142,300 volumes) being at Paris ; and that in Great Britain, which has only nine university libraries, containing 1,849,600 books, more than 1,000,000 of these are about equally divided between Oxford and Cambridge. It should, however, be remembered that the large public libraries, such as, for example, the British Museum in England and the Bibliothèque Nationale in France make up in part for deficiencies in the universities. The four largest libraries are Strasburg (704,076 volumes, with an annual appropriation in 1894 of $16,363); Leipzig (504,683 volumes, appropriation $9,520); Oxford (530,000 volumes, appropriation $41,531) and Cambridge (506,500 volumes, appropriation $9,520), while the libraries at Göttingen, Heidelberg, Munich, Vienna and St. Petersberg each contain more than 400,000 volumes.

ACCORDING to the report in *The Lancet* M. A. Lachenal's inaugural address before the International Congress of Criminal Anthropology at Geneva was a brilliant review of the three previous Congresses—that at Rome having startled the lay and especially the legal world with the thesis that there are born criminals and that there exists a criminal type anatomically determined; while its successor at Paris strengthened this position by insisting not only on the anatomical, but still more on the physical 'conditions precedent' of crime, which conditions, so interpreted, yield 'a biological and moral portrait' set in the social background in which the criminal lives. At Brussels the juristic view of the question intervened, and while admitting a 'natural history of crime'

sought to furnish an eclectic theory of the phenomenon in which biology and law were equally represented. To-day in Geneva the discussion is resumed and, whatever modifications these provisional solutions of the problem may yet undergo, their effect must be to impress both parliaments and people with the necessity of 'raising a penal system which, without confounding the prison with the hospital, will recognize a moral clinique as well as a repressive code,' and so tend to 'eliminate the elements which are unfit for social life and dangerous to humanity.'

PROF. L. H. BAILEY'S *Nursery Book*, first published in 1891 by The Rural Publishing Company, has now been thoroughly revised and re-cast and published by The Macmillan Co. as the third volume of the Garden Craft Series. The book contains a strictly scientific treatment of 'seedage,' 'separation and division' 'layerage,' 'cuttage,' and 'graftage,' together with an extended nursery list, filling 191 pages. The author has incorporated in this edition a paper read before the Peninsular Horticultural Society in 1892, in which it is argued that while grafting is not suitable to all plants it is not a devitalizing process for those on which it can be adopted. The wide sale of Prof. Bailey's book shows that practical gardeners are able to appreciate a scientific treatise on their art.

DR. D. WALTER has published in the *Naturwissenschaftliche Rundschau* experiments on the diffuse reflection of the Röntgen rays, made in the State Laboratory of Physics at Hamburg. More than twenty elements were used, the reflecting surfaces being separated from the photographic film by a thin sheet of black paper, while the rays passed through the glass. The amount of diffuse reflection was in relation to the position of the elements in the periodic system, being the greatest for the silver group, and decreasing on both sides. The decrease in passing from the silver to the platinum group was considerably larger than the increase from the copper to the silver group. No reflection could be detected in the case of the diamond. The angle of incidence of the rays made no difference, nor did it matter whether or not the surface was polished, but the order of the substances was different when the surface was not parallel to the film.

WE learn from *Kantstudien* that a new life of Kant by Dr. M. Kronenberg is about to be published by Beck, of Munich, and that Prof. Fr. Paulsen has in preparation a volume on Kant for *Frommanns Klassikern der Philosophie.* Volumes in this series on Fechner by Prof. K. Lasswitz, on Hobbes by Prof. F. Tönnies, and on Kierkegaard by Prof. H. Höffding, have already been published.

THE *Revue Scientifique* states that M. Vallot has this year entertained at his meteorological observatory four Frenchmen, three Swiss, one German, one Italian and one American. M. Vallot generously entertains all meteorologists who wish to make observations at this station, which is the highest in Europe, being 4,385 m. above the sea and only 427 m. from the summit of Mt. Blanc.

THE Committee of the British Association on Zoological Bibliography and Publication make the following recommendations: (1) that each part of serial publication should have the date of actual publication, as near as may be, printed on the wrapper, and, when possible, on the last sheet sent to press. (2) The authors' separate copies should be issued with the original pagination and plate-numbers clearly indicated on each page and plate, and with a reference to the original place of publication. (3) That authors' separate copies should not be distributed privately before the paper has been published in the regular manner. The Committee further asks for cooperation in the following rules of conduct upon which the best workers are agreed, but which it is impossible to enforce, and to which it is difficult to convert the mass of writers. These are: (4) That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible. (5) That new species should be properly diagnosed and figured when possible. (6) That new names should not be proposed in irrelevant foot-notes or anonymous paragraphs. (7) That reference to previous publications should be made fully and correctly, if possible in accordance with one of the recognized sets of rules for quotation, such as that recently adopted by the French Zoological Society.

ACCORDING to *Natural Science* the Geological

Society of South Africa, which was founded last year for the purpose of preserving the records of the earlier geologists who have written on South Africa, as well as of promoting discussion and investigations on the more recently discovered portions of the colony, has lately come into possession of a most valuable collection of manuscripts and papers, written principally by the late Mr. Andrew Geddes Bain and Mr. G. W. Stow. Among these are the original drawings on a large scale, colored, of all the sections taken across the country by the late Mr. Stow, and also the numerous papers, including lectures, read before various scientific societies by the father of South African geology, Mr. Andrew Geddes Bain. The Society is at present discussing the advisability of erecting a permanent building, to be used as a museum and meeting room; upon its walls the drawings of Mr. Stow would be exhibited. Mr. David Draper, the secretary of the Society, is at present on a short visit to England.

WE have already noticed among the numerous international congresses meeting this year, the Congress of Hydrology, Climatology and Geology, held at Clermont-Ferrand, Puy de Dôme, from September 28th to October 4th. Among the subjects proposed for discussion in the Section of Hydrology are: The therapeutic action of various mineral waters; what is thermal treatment? carbonic acid and alkaline bicarbonates in mineral waters, and their therapeutic action; legislation relative to mineral waters, and sanitary police of thermal stations; collection, sterilization and bottling of mineral waters. In the Climatological Section the subjects for discussion include such questions as the influence of altitude, of light, of dust in the atmosphere, etc. The list of excursions includes visits to Royat, Châtet Guyon, Vichy, Néris, Bourboule, Mont Dore and Saint Nectaire, and ascent of the Puy de Dôme, and other expeditions.

UNIVERSITY AND EDUCATIONAL NEWS.

THE first volume of the Report of the Commissioner of Education for 1893-94, presented on June 20, 1895, has but just been issued by the government printing office. The volume contains, in addition to the usual statistics of American schools and universities, extended reports of the condition of education abroad, and a number of papers on special subjects. It appears that there are now 476 colleges and universities in the United States in addition to 156 colleges for women only and 63 colleges of agriculture and the mechanic arts. In the 476 colleges and universities there were 10,897 professors and instructors, 60,415 collegiate students, 3,026 resident graduates and 21,265 professional students. A much larger percentage of the population attend college in the New England States than in New York, New Jersey and Pennsylvania, and some of the Western States have a large representation. Thus while for each 100,000 of the population there are in New York 117 students in college and in Pennsylvania 94, there are in Oregon 184 and in Nevada 197.

THE main building of Mt. Holyoke College, at South Hadley, Mass., was destroyed by fire on September 27th. The loss will probably amount to $200,000, but there was that amount of insurance on the buildings. The building of the Northern Illinois College, at Fulton, was destroyed by fire on September 26th. The loss is estimated at $100,000.

THE State Veterinary College, located at Cornell University, for which the State has provided $250,000 for buildings and $30,000 annually, will open with more than two hundred students.

THE Polytechnic school, the establishment of which, at Peoria, Ill., by Mrs Julia Bradley, we announced sometime ago, will be affiliated with the University of Chicago, two of the seven trustees being members of the University. Mrs. Bradley will support the school during her life and at her death the entire estate, estimated at over $2,000,000, will be bequeathed to it.

SEVERAL universities report a large increase in the freshman class this autumn. 350 freshmen have been admitted to the University of Pennsylvania, which is an increase of 134 over the class of last year. The Sheffield Scientific School has this year a class of 180, as compared with 150 last year.

AT the Teachers' College, New York, Dr. James Newcombe has been appointed lecturer

on physiology, and Mrs. F. C. Torrance to be assistant in mathematics. Mr. Richard E. Dodge has been promoted to an associate professorship of natural science, and Miss E. B. Sebring to an associate professorship of the history of education.

Mr. James R. Bailey, M. A., a graduate of the University of Texas, after a three years' course at the University of Munich, has just been appointed instructor in chemistry in his *alma mater*. He will be associated with Prof. Henry Winston Harper.

A post-graduate course of bacteriology has been established at the University of Sydney, N. S. W.

Dr. H. Minkowski, professor of mathematics in the University of Könisberg, has been called to the Zurich Polytechnic Institute. Dr. Graeff, of the University of Freiburg, i. Br., has been made assistant professor of mineralogy and petrography. Prof. Erismann has resigned the chair of hygiene at the University of Moscow.

DISCUSSION AND CORRESPONDENCE.

GEOLOGY IN THE COLLEGES AND UNIVERSITIES OF THE UNITED STATES.

Under this title* Prof. T. C. Hopkins has collated some very interesting data concerning the teaching of geology in the United States, which, if properly analyzed, cannot fail to impress upon the reader the fact that in some branches, at least, our university instruction is not only defective, but largely in the hands of amateurs.

As is well known, geologic study and research are not only growing in favor, but are now recognized as essential in any institution offering instruction in pure science. Moreover, the practical application of geologic truth earns for geology a place in many of the technical schools. That so important a study should be so neglected by American universities and colleges is, indeed, surprising. In Mr. Hopkins' paper 382 institutions are reported as teaching geology. By an examination of the tables furnished, corrected in a few instances by reference to the text, I find but 54 of that number offer instruction exceeding one year in length. Of the 54 thus selected four are not recognized in the body of the report as possessing any professional merit. Of the 50 now remaining 40 have established separate chairs, while 10 have geology combined with some other subject.

Another fact is interesting in this connection: The Geological Society of America, an association embracing, it is thought, not less than 90 per cent. of the trained geologists of this country, is represented in but 58 of the 382 institutions.* In the 50 institutions of reputation, giving instructions exceeding one year, the Geological Society is represented in 39; in the 40 with separate departments it is represented in 34.

The conclusion to be drawn is now apparent, viz.: That the instruction offered in the majority of American universities and colleges is given by amateur geologists, who claim no recognition in the science they teach; offer no contributions; conduct no investigations; who are content to read with a class or hear a class recite. The true teacher must be able not only to read a text, but to interpret a text as well, and, what is of still greater importance, read nature and interpret her actions. A teacher inspires a student in precisely the degree in which he himself is inspired. If he be a 'textbook geologist,' it is reasonable to expect that his students will take their geology from books rather than from nature; if he be a 'working geologist' that his students will seek the field, will frequent the laboratory.

The point I wish to make is this: Without a doubt the majority of institutions are teaching geology in an utterly inadequate manner, without proper facilities and by means of teachers unknown and unrecognized in the science. Some of these may be doing fairly good work; but the presumption is that the work will not, cannot, be of a high order.

But the mischief does not end here. Students from these institutions go forth with the

* 'Geology in the Colleges and Universities of the United States,' by T. C. Hopkins, being Chapter III. of the forthcoming Report of the Commissioner of Education, United States Bureau of Education, Washington, 1896.

* See list of Fellows, April 1896, *Bulletin of the Geological Society of America*, Vol. VII., p. 530, *et seq.*

idea that they have mastered geology; have they not recited so many weeks from a text-book? They have been misled. Education is more than a mere matter of the memory—a storing away of facts, as valuable as they may be; it is the cultivation of those powers by which the facts may be obtained at first hand. In this lies the training.

I am well aware of the excuse offered. Says the college president: "We do not pretend, nor do we care to make trained geologists; we wish to give our students an insight only into the science, that's all." Let me ask: How much chemistry worth the having can be obtained by reading or committing to memory the ordinary text-book? How much physics? How much biology? In a collegiate institution courses are offered in these branches for their *training* effect, without reference necessarily to the career of a student. Chemistry, physics and biology cannot, in these days, be taught without an equipment and teachers well versed in its management. Why should geology receive different treatment? Its demands are not less pressing and its educational value is fully as great. When the services of professionals can be obtained, why longer impose amateur instruction upon our students?

The root of the evil seems to lie not only in the want of a proper discrimination on the part of the patrons of educational institutions, but largely in the lack of a proper appreciation on the part of the authorities in charge. That more and louder protests have not been heard is strange. But the pace has been set. Those institutions which persist in offering cheap instruction, solely because it is cheap, must fall to the rear. That the best instruction will be given by the best trained teacher is axiomatic. Better by far that geology be not attempted than that it should be poorly presented; better that a curriculum be curtailed than that a study should be a source of weakness.

FREDERIC W. SIMONDS.
SCHOOL OF GEOLOGY,
UNIVERSITY OF TEXAS, August, 1896.

ON A SUPPOSED IMMEDIATE EFFECT OF POLLEN.

TO THE EDITOR OF SCIENCE: I have been greatly interested in the account of a curious freak in an apple tree given by Mr. T. H. Lennox in your issue of September 4, 1896, p. 317. After describing the freak, Mr. Lennox concludes that "there can be no reasonable doubt that the phenomenon arose from cross fertilization between pollen of tho Talman Sweet and the ovule of the Greening." As some of the features of the case, as described by Mr. Lennox, seem to me opposed to such a conclusion, I venture the following suggestions:—

The apples on the northeast side of the tree, we are told, "were Rhode Island Greenings, such as the tree had always borne, while those on the southwest half of the tree were of a mixed character, *each apple being partly Greening and partly Talman Sweet.*" If the phenomenon is to be attributed to the direct action of the Talman Sweet pollen, it is difficult to understand why every apple on one half of the tree should be affected and none on the other half of the tree. As the pollen is normally carried by insects we should possibly expect a greater number of the fruits to be affected on the side toward the Talman Sweet tree than on the opposite side, but we should reasonably expect a portion of them to remain unaffected. We should also reasonably expect a few fruits on the opposite side of the tree to be similarly affected, as some of them would as surely be crossed with the Talman Sweet pollen as those on the side nearest the Talman Sweet tree. In other words, if this freak were due to cross pollination by insects with pollen of Talman Sweet, we should expect the fruits affected to be scattered irregularly over the tree, the majority being on the side adjoining the Talman Sweet tree. That the fruits on certain limbs or a certain part of the tree only should be affected and all of these similarly affected, is indeed difficult to explain as a result of cross pollination. One must necessarily presuppose a peculiar condition of this portion of the tree rendering possible the effect of the pollen described, as the other portion of the tree remains entirely unaffected. This is evidently Prof. Bailey's conclusion, as in his note following the article by Mr. Lennox he says: "Like heredity of mutilations it (the immediate effect of pollen) is rare and therefore apparently exceptional." Even when we assume some pecu-

liar condition of the limbs exhibiting the phenomenon the difficulty is not altogether passed, as we must still explain how it happens that all the flowers, which open quite irregularly, were pollinated with pollen from the same variety. Mr. Lennox himself calls attention to the difficulty in understanding why such results, if rightly due to the effect of pollen, as supposed, are not more common considering that cross pollination unquestionably occurs commonly in all orchards.

I am not familiar with the history of the varieties concerned and cannot suggest whether or not it is possible to consider this a reversion such as sometimes occurs late in the life of an individual. Partial reversion by segments in the same fruit, on certain limbs or the entire tree, is not of uncommon occurrence.* Such stripes, further more, are evidently not necessarily due to reversion to characters derived from a cross, but frequently to characters lost by variation. It would seem to me not at all improbable, from the facts given, that this might be such a case of reversion in certain branches. It should be remembered in this connection that Darwin has given several cases of stripes on apples similar to the case in question, which cannot be explained as effects of cross pollination.† It is a common occurrence for oranges to produce segments of rind resembling lemon or citron, and these are commonly considered to be due to the immediate effect of pollination. These modified segments, however, are not infrequently found at considerable distances from lemon or citron trees, and they do not occur more frequently, so far as I have been able to observe, when branches of the orange and lemon are near together or interlocked. It is very probable that they are in most cases to be attributed to reversion. Occasionally navel fruits occur on almost all orange and lemon varieties and are commonly believed to be positive evidence of the immediate influence of navel pollen. Yet I have proven by numerous dissections that the navel is invariably formed early in the development of the pistil, weeks before it reaches the stage for pollination. It is well known that certain varieties not navels more commonly produce navels than certain other varieties. On these varieties, again, the navel development may be found in some of the pistils long before pollination. The development of the navel is a profound morphological change originating early in the development of the pistil, and I think its production lies entirely outside the possibilities of pollen modification. Again: the absence of mature pollen in every navel anther examined by Prof. Van Deman and his assistants and myself makes it highly improbable that navel marks in oranges can ever be interpreted as due to the immediate effect of navel pollen. There is, unquestionably, a marked tendency among the various varieties of citrous fruits to sport in this way, and the isolated cases of navels on other varieties are merely illustrations of this tendency.

It is not impossible that a combination of the characters of two varieties on a portion of one tree, where two trees of the varieties concerned are growing quite near together as in the case described by Mr. Lennox, might be caused by graft hybridization produced by the fusion of roots from the different trees. I am not aware that any such case has ever been recorded or even suggested, but it is surely within the limits of possibility, as roots from different trees, which become closely associated or crowded together, sometimes fuse. I have observed in one case a fusion of two orange roots from different trees and have not infrequently observed the fusion of roots from the same tree. It is probable, however, that the case described by Mr. Lennox could not thus be explained, as I suppose the trees concerned were grafted on other roots. I presume Mr. Lennox is sure that the stock, on which the Greening is grafted, is in no way related to the Talman Sweet or any similar variety, and has never been 'double-worked,' that is, grafted twice with possibly a section of Talman Sweet remaining in the trunk. These are suggested as details which one must know positively before excluding their possible action.

The immediate effect of pollen is a much disputed question in horticulture, and one which demands the most careful experimental evidence to satisfactorily confirm. That there is

* See Darwin, Animals and Plants under Domestication, II., p. 10. et. seq.

† l. c., I., p. 425.

some doubt as to whether the case described by Mr. Lennox can be considered an immediate effect of cross pollination, I think everyone critically examining it will admit. If due to reversion, graft hybridization or cross pollination, the same characters will probably appear on the tree again next year, so that further studies may be made. It is to be hoped that Mr. Lennox will be able to test the validity of his conclusions experimentally.

Horticultural literature has become so filled with descriptions of supposed cases of the immediate action of pollen where insufficient evidence is given to enable one to judge the merits of the case, that it behooves observers to be exceptionally careful in regard to all conditions if any final conclusions are to be reached.

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THE DEFINITION OF CIVIL ENGINEERING.

THERE is an error in my paper on the Artistic Element in Engineering which I should like to correct. Following the lead of other writers, I have ascribed the classic definition of civil engineering to Telford instead of to Tredgold, whom I have recently learned was its author. See *R. R. Gazette* of December 28, 1894, page 883, or of August 28, 1896, page 602.

I am indebted to Mr. H. G. Prout, of the *Gazette*, for calling my attention to the matter.

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SCIENTIFIC LITERATURE.

Studies of Childhood. JAMES SULLY. New York, D. Appleton & Co. 1896.

This book is a series of topical or classified studies of certain phases of the psychology of child life, covering, upon the whole, the period of life from two to six years of age, with quite a marked preference for those phenomena which dawn or are at their height in the second and third years. The topics covered are: The imagination of childhood; its reasonings, including a study both of the process and the more marked and characteristic processes; the beginnings of language; the emotion of fear; some phenomena of morality, including a study of children's egoism, altruism, lies, and an account of their reactions to the moral injunctions of their elders; and a study of the child's æsthetic nature as manifested in his instinctive expressions and in his primitive drawings. The book concludes with a detailed individual study (covering about 100 pages) of one of his own children; and a very interesting study of the childhood of George Sand, drawn from the latter's autobiography. In this connection it may be remarked that a distinct feature of the book is not only the author's own style, which is literary rather than 'scientific,' but his wide acquaintance with autobiographical allusions to childhood and his apt use of such reminiscences. Ruskin, Dickens, Quinet, Tolstoi, Stevenson and many others figure in these pages.

This topical character of the treatment practically makes any synopsis of the book, beyond such a bare scheduling of headings, out of the question. An immense number of relevant observations of childhood, gathered from practically all available sources, supplemented by Mr. Sully's own observations, and enlivened by judicious remarks upon the salient qualities of childhood, make the book what it is. The hypercritical will probably conceive that the running commentary is sometimes discursive, occasionally dangerously near the padding point, and frequently of no great importance. But I confess myself sufficiently grateful in finding a book to review which is interesting to read as well as technically instructive.

The impossibility of summarizing the material content of the book makes it advisable to direct attention to the method, both what Mr. Sully himself says about method and that which he actually employs. As to the former, Mr. Sully devotes considerable space in his introduction to the objects and difficulties of child study, and to an account of the equipment necessary for observation and interpretation. The interest in child-study he finds to be partly due to the general development of natural science and partly to specifically psychological needs. The infant is, so to speak, more obviously a natural phenomenon than the adult; and the evolutionist in particular finds in him obvious signs of close kinship with the animal world, both in the foetal and early post-foetal stages. The

ethnologist also finds in the child a summary of the prehistoric development of the race. To the psychologist the opportunities of escape from the interwoven complexities of the adult consciousness make this a promised land of science. Yet the difficulty even with the reference to the outward phenomenon is very great; witness the difficulties in identifying the first smile of the child, his first sign of recognition, his first conscious attempt in any direction. And, of course, the difficulty is still greater when we come to interpret these movements into their psychical equivalents. These difficulties are so great that the author 'confesses that in spite of some recently published highly hopeful forecasts of what child-psychology is going to do for us, I think we are a long way off from a perfectly scientific account of it;' a remark to which no one will take exception if there is much emphasis upon the 'perfectly.'

There are two qualities necessary for good work. The first is the 'divining power,' sympathetic insight, tact or fineness of spiritual insight. This is required both for such rapport with children as to establish the conditions for natural, unconstrained exhibition of genuine phenomena, and for interpretation. (Mr. Sully's own work, I remark in passing, shows a very unusual amount of such native divining tact and personal sympathy). There is danger, however, that the very liveliness of this touch with child-life will take off the edge from close, objective, systematic study of the bare, cold facts. Hence the second requirement, good psychological training. Fathers, Mr. Sully thinks, are more apt to come short as regards the first of these qualifications; mothers as regards the second.

As concerns method in general most is to be expected from the prolonged observation of individual children such as is represented by the work of Preyer and Miss Shinn. Mr. Sully's remarks here are so much to the point as to justify quotation in full. 'No fact is really quite simple, and the reason why some facts look so simple is that the observer does not include in his view all the connections of the occurrence which he is inspecting. * * * * It is only when the whole fact is before us, in well-defined contour, that we can begin to deal with its meaning.' And of course, this wholeness of the fact presupposes knowledge of the individual child, his environment, history, temperament, etc. When we come to older children this specific individual study may be supplemented by more general and statistical collections.

All this seems to me well and judiciously put. Mr. Sully's own work in the pages which follow bears evidence throughout that he realizes practically, as well as theoretically, the limitations, the problems and the needs of which he has been talking. Nevertheless, there are reasons for holding that this book will be to the psychologist, at least, rather 'raw materials to serve' than a contribution to psychology as such.

It is possible to go at the study of the child with the purpose of arranging the observed phenomena under the customary rubrics of psychology, laying emphasis upon extreme exhibitions of principles which are discernible only feebly or subtly in the adult, or upon the phenomenon which mark departures from the forms which are familiar in the adult consciousness. Here, however, unconsciously, *the adult consciousness as already analyzed is taken as the standard.* Another method treats the child consciousness as, if I may use the expression, perfectly good consciousness on its own account, just as good consciousness as the adult. The interest is wholly in the light which such consciousness may throw upon psychical principles in general. The aim is not to classify the phenomena under principles already accepted, but to reconstruct those principles from the study of facts hitherto neglected. Mr. Sully's actual procedure seems to me to adopt the first named course. He rarely uses the new facts to criticize and modify the customary classifications and explanations, but rather takes these latter for granted and crowds the observations under them—with some projecting edges.

As an example, we may take his theoretical treatment of imagination in childhood. After making a good beginning by remarking that "imagination in an active, constructive form takes part in the very making of what we call sense-experience," he goes on to give cases of the personification of inanimate objects in per-

ception, and takes up the argument as follows: "Now, it may be asked whether all this analogical extension of imagery to what seem to us such incongruous objects involves a vivid and illusory apprehension of these as transformed. * * * A conjectural answer can be given. In this imaginative contemplation of things the child but half observes what is present to his eyes, one or two points only of supreme interest in the visible thing, whether those of form, as in assimilating the piano-hammer to the owl, or of action as the *falling* of the leaf, being selectively alluded to, while assimilative imagination overlaying the visual impression with the image of a similar object does the rest. In this way the actual field of objects is apt to get veiled, transformed by the wizard touch of a lively fancy."

Now, from the standpoint of a certain psychology, the customary one, this is very well said. But it merely assumes, without questioning, two things which the facts discussed are well adapted to make us question: the 'actual field of objects,' 'what is present to the eyes' on one side and the imagination or fancy, as some sort of distinct power on the other. But is not this somewhat naive? Is this reference to the 'actual field of objects' anything more than making the special constructions of the adult consciousness, made from the standpoint of its supreme interests, the fixed standard? Is the problem how and why the child overlays the things present to his eyes with fanciful unrealities one of his own inner being? Or is it why and how the growing consciousness gradually shears down the original experience, inhibiting the larger part of the interests which determined it, and gradually confines itself to one or two definite ends and habits in selecting the qualities which shall constitute the world of things? In a word, is the child object the adult ('or real') object with an overplus of fanciful fringe, or is the adult-object the child-object pared down and rearranged to meet the dominant needs of mature life—one being just as 'real' as the other in an abstract or metaphysical sense?

I do not mean to affirm that Mr. Sully is wrong in choosing the former alternative. But the fact that he has adopted it without considering there is an alternative, indicates to my mind that, for the most part, he is just classifying the new scientific material under the old headings, instead of remaking the point of view.

From the standpoint of the scientific psychologist this is an important qualification regarding Mr. Sully's work. Quite probably, however, it fits the book all the better for the task of mediating between the psychologist and the public of parents and teachers into whose hands the book will fall; and, as there are many signs that this is the end the book has in view, it is a pleasure to add that it fulfills this particular purpose better than anything as yet published upon child psychology. A good index adds materially to the usability of the book.

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The Whence and Whither of Man: A brief history of his origin and development through conformity to environment, being the Morse lectures (at Union Theological Seminary) for 1895. By JOHN M. TYLER, Professor of Biology, Amherst College. Charles Scribner's Sons, New York. $1.75.

The Morse lectureship was founded by Prof. S. F. B. Morse in 1865 at Union Theological Seminary, the lectures to deal with 'the relation of the Bible to any of the sciences.' These lectures for 1895, which are just published, deal with some of the most fundamental of all the relations between scientific and religious belief, and that in such a candid and fearless spirit as to at once win the attention and respect of all persons who love the truth and believe that a free expression of opinion is the best way of advancing it. The lectures include such topics as the fundamental properties of living things; a brief consideration of Classification, Ontogeny and Phylogeny; the probable course of evolution from amœba to man; the history of mental development and its sequence of functions from reflex-action to reason and altruism; natural selection and environment, making at first for digestion and reproduction preeminently, then for muscular strength and activity, then for shrewdness, finally for unselfishness and righteousness; conformity to environment; man from the biological, social and religious stand-

point; finally a chapter on the teachings of the Bible relative to the subject in hand and another on the present aspects of the theory of evolution in which are considered a number of modern theories as to causes of evolution, inheritance and variation.

These lectures present the evolution idea not from the theological, but from the scientific point of view. They are largely biological in content and spirit though addressed to theologists. The author does not attempt to prove everything, but takes many elementary principles for granted, among them the truth of the entire doctrine of evolution. One is consequently spared the weariness of listening to a labored argument to prove the truth of fundamental ideas, which everybody, except a few immutables, believes. On the other hand it presents in a clear and suggestive way many of the more recent developments of the evolution idea. It does not purport to be an original contribution to knowledge, but it is a valuable and extremely well written book of the 'educational' type.

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SCIENTIFIC JOURNALS.

THE ASTROPHYSICAL JOURNAL, AUGUST.

The New Elements of Clèveite Gas: By J. R. RYDBERG. In referring to the work of Runge Paschen and regarding the reduction of the spectrum of clèveite gas, the writer recalls the following simple law, announced some time ago by himself: *The difference between the common limit of the nebulus and the sharp series, and the limit of the corresponding principal series, gives the wave number of the common first term of the sharp and principal series.* This law holds good to a considerable degree of approximation for the alkali metals Li, Na, K and Rb, which have corresponding triple series, and is proposed as a criterion of the proper *mating* of the subordinate with the principal series. If we denote the principal series by P_1 and P_2 and the subordinate sets by S_1 and S_2, and assume that P_1 belongs with S_1 and P_2 with S_2, the law will hold; otherwise, in general, it will not.

In the correspondence chosen by Kayser and Runge the criterion is satisfied within the limits of observational error. The values of the first terms (in wave numbers, per cm.) of the principal series are as follows:

	Computed.	Observed.	$C-O=\triangle$
Pa	4857.79	4900.65	-42.86
He	9230.22	8950.14	$+280.08$

Although the $\triangle$'s are well within the limits of error for the observation of this first line, which is in the infra-red and must be measured with the bolometer, there is evidence, in the case of He, of a probable disturbance due to the proximity of Na λ 11392.5, the sodium lines being strong in the visible spectrum. The author, therefore, concludes that the computed values of the lines are the most accurate. More accurate determinations of the lines in question will be of extreme value in testing this most interesting law.

Attention is also called to another law due to the writer, which seems to show Parhelium to be of uneven and Helium to be of even valency.

Outlines of a Theory of Spiral and Planetary Nebulæ: By E. J. WILCZYNSKI. 1. A theory to explain the peculiar formation of spiral nebulæ. The writer supposes a mass of nebulous matter to be moving in a circle under the action of a central force. In case the mutual attractions of different parts of the mass upon one another are insufficient to resist distortion, it is shown that the different parts of the mass must be moving in concentric circles, the common center, of course, being the attracting body. Under these conditions it is evident, from Kepler's third law, that those portions of the nebulous mass nearest the center of the circles must rotate faster than those furthest away. In this manner a former radial line in the nebula will be distorted into a spiral.

The writer suggests that this gives us a means of approximating to the age of the nebula (as a spiral).

2. If a nebula has the shape of a flat disc, then the following differential equation exists between ρ, the density at any point, r, the distance of the point from the center, and ω, the angular velocity of the point, where ω and ρ are both supposed to depend only upon r.

$$\frac{d^2\rho}{dr^2}+\frac{1}{r}\frac{d\rho}{dr}-\frac{1}{\rho}\left(\frac{d\rho}{dr}\right)^2+4\frac{\pi}{c}\rho^2 = \frac{\rho}{c}\left(2\,\omega^2+r\frac{d\omega^2}{dt}\right)$$

If we know $\rho = f(r)$ we can now solve for ω. Assuming ρ proportional to the brighness, it is suggested that we find by observation

$$\rho = f(r)$$

and the angular velocity of the nebula at any point may be found, except with regard to the constant of integration.

Hydro-dynamical Investigation of the Solar Rotation: By E. J. WILCZYNSKI. An application of Lagrange's differential equations for the motion of a fluid, to the case of the sun. Assuming the sun to be gaseous, it is found that the angular velocity of any point within it or upon its surface depends only upon its distance from the axis of rotation, and the distribution of density and pressure within the sun as a whole, *i. e.*, all points on a cylinder with the sun's axis as center revolve with the same angular velocity, but the differential slipping of these cylinders upon one another depends upon the internal conditions of temperature and pressure. If another relation between these three quantities ω, ρ and t could be found, the above conditions could be found as functions of the observed law of rotation.

Researches on the Arc Spectra of the Metals. II. The Spectrum of Titanium: By B. HASSELBERG. The article is devoted to a consideration of the spectrum of titanium, from λ 3450 to *D*. Our present knowledge of the spectrum rests upon Thalen's work of thirty years ago, and consequently is not accurate as measured by modern standards. Many new lines have been discovered by the author and some of the old ones resolved. Extreme care was taken to eliminate impurity lines. All lines occurring within 0.1 meter of lines catalogued as belonging to other metals were compared with them on the same photographic plate and classified as follows:

A. As belonging to titanium.

(*a.*) All lines distinctly separated from those of comparison metal.

(*b.*) Those lines coinciding with comparison lines but having greater intensity.

(*c.*) Lines exactly coinciding and strong in both spectra (probably belonging to both).

B. As *doubtful.* Lines coinciding, but so feeble in both spectra as to make them possible results of a common impurity.

C. As *impurity* lines, those weak in titanium spectrum and strong in comparison spectrum.

Comparisons with the spectra of Fe, Co, Ni, Cr, Mn, Mg, Zn, Hg, Al, Pb, Sb, Na, K, Cs and Th, served to eliminate many impurity lines. These metals have been investigated by Kayser and Runge, and the comparisons cast doubt upon the legitimacy of some of the lines catalogued as belonging to these elements.

Minor contributions and Notes, including 'On a New Method of Preparing Plates Sensitive to the Ultra-violet Rays,' one of the series of articles by V. Schumann.

Reviews of recent papers on astro-physical subjects.

THE MONIST—OCTOBER.

C. LLOYD MORGAN, in *Animal Automatism and Consciousness,* examines Huxley's and Descartes's views, rejects the theory that consciousness is a collateral product of brain action, and claims for consciousness a rôle of guidance both in the acquisition and utilization of habits, all of which is effected by association and suggestion.

In *The Regenerated Logic,* C. S. Peirce submits to critical examination Ernst Schroeder's great work, discusses the way in which professional opinion is formed, treats of the nature and scope of logic generally, and of 'assertion,' of hypothetical and categorical propositions, and of the quantification of the predicate in particular.

The third article is by E. Douglas Fawcett and is entitled *From Berkeley to Hegel,* being a chapter of the history of philosophy 'embodying a critique of the panlogist phase of idealism.' The treatment is thoroughly speculative in character (the author attempting to resuscitate the Leibnitzian monadology), and hence is the occasion of a reply from the editor, Paul Carus, who, under the caption of *Panlogism,* expounds anew his theories of mind, the soul and immortality.

The concluding article is by George Bruce Halsted, *Subconscious Pangeometry,* and treats of certain mooted points in the history of the theory of parallel lines and of the Non-Euclidean geometry. The usual correspondence follows, with quite a long list of reviews of important publications in philosophy and science.